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CULTIVATED FIELDS.

By E. W. PREVOST, PH.D.

IN a former number (No. V.) of KNOWLEDGE, the formation of the soil of a field was described as succinctly as possible, and it was then shown how a certain class of rock was caused to yield a loam fit for the growth of plants. It is now proposed to continue the subject, and to point out how, by the present methods of cultivation, soil can be brought into a higher condition of fertility than it would otherwise possess, if left only to the action of the weather.

It is generally found that there exists below the surface soil a layer of earth of a character somewhat different to that of the upper layer. This has been termed the *subsoil*, and we shall see later on that its composition may exert a considerable influence on the fertility of the surface soil. The methods of cultivation which we propose to consider (as also the reasons why they are employed), are draining, ploughing, and manuring. If water be poured upon some clay soil, placed in a suitable vessel, it will be noticed that some of it will pass through the soil, and that the rest will be retained; but, depending on the class of soil under examination, the amount of water retained will be greater or less, a clay soil retaining much, a sandy soil but little; this property of holding back some of the water which falls upon soil has been termed the retentive power, and it exerts a very great influence on the luxuriance of crops, for when a soil remains wet, its temperature cannot rise as high as if it were dry, and is consequently "cold." Such a "cold" land militates against the germination of seeds. On the other hand, if the retentive power is low, then the land dries quickly after a fall of rain, and the plants run the risk of being scorched by the heat of the sun. Now, it may occur that a soil is not naturally retentive of water to any great extent, yet an excess of water may be observed incapable of passing away from the surface; the cause of this stagnation may be found, on examination of the under-lying portion of the land, to arise from a bed of clay that will not admit of the downward passage of the water. This or another arrangement of the deeper portions of a field has given rise to the modern system of draining, which by causing the removal of the excess of water, and its more even distribution through the soil, permits of the entrance of air into its pores, whereby decomposition of the insoluble minerals is occasioned, and of a higher temperature being attained. Nor are these the sole advantages, but an excess of soluble saline matter, injurious to plants, such as stagnant water will deposit, is obviated, and the roots of plants are enabled to seek for their food at a greater depth than they otherwise could. Apart from these considerations affecting the well-being of the crops, there is also the great gain to the cultivator, in that the labour of tilling a soil sodden with water is far greater than when the land is fairly dry. The various methods in use for breaking up the surface of a field that pass under the name of tillage operations produce effects both physical and chemical; for by ploughing, the condition of the soil is improved, the soil being rendered less compact, dried from superfluous moisture, and exposed to the decomposing action of the air, whereby as before stated, solution of the minerals is facilitated. This decomposition has, however, been in progress but more slowly all the year round, and some of its products have been carried deep down by the rain; these the plough brings to the surface, thus adding to the stores requisite for the future crop. Sometimes, when the ploughing is carried too deep, the results are far from satisfactory, the land becoming for a short time less fertile than previously. When such an event as this happens, we may be nearly certain that the sub-oxide of iron has been brought to the surface, where it must remain until it becomes peroxide by exposure to the air, and after that the land may resume its original condition of fertility. Hence it is desirable on all accounts to allow a newly-ploughed field to remain untouched for some time, and the more so if the ploughing has been deep. It appears, then, that ploughing is in some measure supplementary to draining, and *vice versâ*, as without draining, a heavy wet soil can only be imperfectly ploughed; or, rather, the advantages following on ploughing are but in part gained.

By the removal of a heavy crop off a field, a considerable quantity of mineral matter is lost to the soil, which cannot be replaced under natural conditions in amount sufficient to produce a heavy crop in the succeeding season; to get rid of this difficulty it is customary to apply manure to the exhausted field, manures being substances which either of themselves supply food, or else by their action on the soil cause it to yield an increased quantity of available plant-food—at the same time improving its character. It would occupy far too much space to describe the properties, &c., of all the manures in use, so that we will confine our attention to two which are well known to the general public, namely, lime, and farm-yard manure. In the first of these two we have an example of a substance used not so much as a food—for, as a rule, all soils contain a sufficiency of lime for the plants—but as an agent whereby the stores in the soil are rendered accessible; but before being able to appreciate wholly the virtues of lime, we must call to mind what are the chief substances which are of value, and which are likely to be affected by the presence of such a manure; these substances are potash in combination with silica and alumina, and nitrogen contained in the organic matter or humus.

Lime may be applied as caustic or quick-lime, and as slaked lime (quick-lime to which water has been added), but as regards the action of either of these forms, there is no absolute difference, but only one of degree, in that quick lime is more energetic in its action than slaked lime; but to counterbalance the deficiency in energy of the latter, it is more capable of even distribution through the soil, by reason of its fine state of division. Rank and luxuriant herbage

is indicative of "sourness" of the soil. By this expression is to be understood the presence of an excess of acid humic matters; these acid matters on the application of lime are neutralised, and the nitrogen, held in combination in a state difficult of solution, is converted into ammonia, and finally into nitric acid which, combining with the lime, forms a most valuable manure, and one easily absorbed by the plants. The felspathic particles are likewise slowly acted on, the lime taking the place of the potash, which then becomes soluble in water, and fit for absorption by the plants. These, then, are the changes produced by lime; but there is considerable danger incurred if they are allowed to take place too often by repeated applications of the manure, for the organic matter will be reduced too much, as also the potash minerals, which in a poor soil may not be too abundantly present. But lime produces other as well as chemical changes, in that it lightens a heavy soil, and consolidates a light one, merely because it is a substance whose texture is opposed to a clay or to a sand. The lightening of heavy soil is, however, not to be ascribed wholly to the physical admixture of lime, but also to a somewhat complicated chemical change which occurs in the soil. To explain what actually does take place, it is necessary to know that when lime is exposed to the air, it gradually absorbs carbonic acid, and is transformed into carbonate of lime, or chalk; when, then, the acid humic matters of the soil come in contact with the chalk, carbonic acid is set free, but not being able easily to escape, it remains enclosed in the pores of the soil, causing the soil to swell and to become lighter, and, if the evolution of gas be not too great, much benefit is the result; but if, on the other hand, this porous condition is excessive, a loss of fertility ensues, in which case the land is said to be "over-limed." As a proof that this is one of the causes of "over-liming," it may be stated that rolling the land is found to be highly beneficial, as thereby the soil is rendered more compact, a portion of the imprisoned gas being forced out. To produce this porosity, it appears that we are not wholly dependent on lime, as the addition of carbonate of lime tends to produce the same result, and without such violence of action as is exerted by caustic lime.

Considering, next, farmyard manure, we see how different is its working, for by its application, actual food is given to the plant, though not in the form best suited for assimilation; hence the manure is slow in action, and produces its effects over a period of three years, as its constituents are but slowly brought into the soluble condition. Farmyard manure may be considered as consisting of nitrogenous matters, capable of conversion into ammonia, potash in a soluble state, and some phosphoric acid; and besides these compounds, there is a certain amount of organic or vegetable matter, such as straw, partly transformed into humus, and partly in its original condition. When this manure is applied to the fields, the soil retains all the valuable portions as they become soluble, handing them over to the plants seeking for food; but, at the same time, it is improved in character, for, if heavy, it is lightened. It is found that it is principally the straw which renders a heavy soil lighter; for, as it slowly decays, giving off carbonic acid gas, it leaves, as it were, its cast in the soil, thus forming passages which the air can readily traverse. In this decomposition of the straw, we have one of the sources of the carbonic acid which acts upon the lime, as referred to above, and which also aids in the destruction of the minerals, as previously stated in No. V.

According to an analysis of Professor Frankland, the water of the Holy Well of Zemzem, at Mecca, is sewage more than seven times as rich as the average sewage of London.

BABYLONIAN SUN-WORSHIP.

Nabupaliddina was the contemporary of the Assyrian kings, Assur-nazirpal and Shalmanesar, and the sculptured, inscribed memorial of his reign, which has been restored to us, is certainly one of the most important records that have rewarded the explorer in Babylonia. In the upper part of the tablet, the dimensions of which are 2 ft. long by 1 ft. broad, is a small sculptured panel representing the worship of the Sun-god by Nabupaliddina and attendant priests. The god is represented as seated on a throne beneath a baldacchino, or open canopy shrine. He has long beard and hair, like most conceptions of the Sun-god, and holds in his hand a ring, the emblem of revolving time, and a short stick; too small for a sceptre, we may, perhaps, see in this the fire-stick which was closely connected with the Sun-god. Before him, on a small table-altar, is a large disc, ornamented with four star-like limbs and four sets of wave-like rays. Above this group is cut the inscription: "The Disc of the Sun-god, and the rays (of his) eyes." The scene here depicted is clearly indicative of the fact that the priests of Sippara were worshippers of the solar disc and solar rays, and their creed seems to bear a close resemblance to that of the disc-worshippers of the eighteenth Egyptian dynasty, who, under Amenophis III. and his son Khunaten, for some time held their ground against the priests of Ammon. This heretical creed was introduced into Egypt by Thi, the Asiatic wife of Amenophis III., and its tenets have been made the subject of a special memoir by Sir Charles Nicholson. The discovery of this sculpture and inscription from the ruins of the temple of the Sun-god at Sippara tends very strongly to place the origin of the creed in Babylonia. The inscription on the back and front of this memorial tablet is a valuable record of the religious life and ceremonial of the Babylonian temples, and the list of the solar festivals in the fifth and sixth columns shows how far back into the remote past we must place the rise of Babylonian sun-worship. Astronomers will welcome this ancient list of festivals, as it proves very clearly the high character of the astronomical knowledge of the Babylonian priests. The six fixed festivals recorded in this inscription are:—

1. Nisan, seventh day, Festival of the Rays (vernal equinox).
2. Airu, tenth day, Festival of the Rays.
3. Ulul, third day, Festival of the Illumination of the Temple.
4. Tasrituv, seventh day, Festival of the Illumination of the Palace (autumnal equinox).
5. Marchesvan, fourteenth day, Festival of the Rays.
6. Adar, fifteenth day, Festival of Illumination of Palace.

The discovery of an important list of solar festivals such as we have here is an important addition to our knowledge of Babylonian astro-theology. The first month of the Babylonian calendar was the "month of sacrifice," or "the altar," and its position was fixed by the vernal equinox, which was in the time of Nabupaliddina, in the sign of Aries—the ram being the chief object of sacrifice. Students of Biblical archæology will find an abundant fund of matter in the caaefully compiled rules as to the distribution of the sacrificial victims. "Sheep," "oxen," "rams," "fruits of the earth," were objects of sacrifice, and portions of each offering were set aside for the priests. These offerings were burned on the great altar of the temple discovered by Mr. Rassam in the chamber adjoining the record room. The great central court of this temple seems to have been styled "the court of the Sun-god," and there was also an outer court "called the court of Bel."—*Times.*

BRAIN TROUBLES.

Part III.—Distracted Attention.

THE next of these signs—one, indeed, which many mental physiologists set first—is an inability to fix the attention on any subject till the mind has done with it. We have taken the failure of memory first, simply because we believe that this symptom can ordinarily be recognised earlier than inability to fix the attention. The fact would seem to be that, since in ordinary processes of thought, we first recognise or ascertain particular facts, and then commit them to the keeping of the memory, the latter process is naturally the one which first fails us. That it should be taken first is indicated, too, by the circumstance that although many cases can be cited of persons who, although able to direct their attention to a subject, are unable to retain in their memory what has been suggested to their thoughts while thus directed, no case is on record in which this state of things has been reversed, and a person has been able to remember recent facts distinctly after he has lost the power of arriving at fresh ideas by efforts of attention. To mention only one case of the former kind, Dr. Winslow tells of one patient whose memory as to recent events was seriously damaged, while yet his perceptive faculties and reasoning powers were not at all affected. "He conversed with great sagacity, fluency, and acuteness on every subject, but if I permitted a second to elapse in the conversation, he entirely forgot what he had been previously talking of." From the time when his memory thus failed him, he retained his former power of reasoning. "He could discuss at short intervals the most subtle and abstruse political, professional, and literary matters with apparently unimpaired mental vigour; but his memory never recovered its healthy tenacity." It may hence be inferred that temporary loss of the power of fixing the attention (which must be carefully distinguished from mere forgetfulness, that is the habit of being inattentive), is more likely to be a sign of serious mental mischief, than failure of the power of memory. Yet the former, like the latter symptom, indicates in the great majority of cases no serious mischief, though it would be exceedingly unwise to overlook it.

The failure of the power of directing the attention to a subject may show itself in several ways. Thus the mind may be unable even to begin the study of a subject; or it may begin the study and presently wander off to other subjects, despite the most anxious efforts to restrain it from so doing; or suddenly it will seem to cease its action, remaining for a short time confused and, as it were, lost, and then resuming the consideration of the same subject at the point where it had left it, and apparently as acutely and attentively as before. These three forms of distraction are of different significance as symptoms of mental trouble. The first, though undoubtedly it would be very serious in this respect, if persistent, nearly always indicates only that the mind wants rest, and no one who is wise will neglect the warning. The second equally implies that the mind wants rest, though not in equal degree. But the third is usually a sign of serious mischief. We consider it here, not as belonging to those indications of mental disturbance which, without being alarming, should be attended to by all who wish to keep their brains in good working order, but because the nature of the cerebral mischief indicated by such symptoms has been ascertained, and we may hence infer the general nature of the mischief indicated when the less serious symptoms of distraction are recognised, and may so judge what is the appropriate remedy. For, unfortunately, several of the cases in which the mind has been observed suddenly to become confused or lost, resuming its activity and clearness after a short interval, have been followed by severe illness, which has proved eventually fatal.

Among the most remarkable and carefully-observed cases of this kind is that of King Oscar of Sweden, the circumstances of which were minutely detailed by Dr. P. O. Liljewalch, the king's first physician. King Oscar had enjoyed fairly good health during the greater part of his life; but before his last illness it had been noticed that occasionally the heart's action was irregular, oftener in spring than in other parts of the year. In 1851 the heart became very irregular in its movements, and the digestive functions were impaired. Although he soon after recovered to some degree, an attack of typhus fever, following the loss of a beloved son, severely tried his constitution, when, slowly recovering strength after this, he unwisely omitted his usual autumn rest and excursion, and devoted his mind to political matters requiring close and anxious attention. In 1857 his health again gave way, and it was at this time that the nervous mischief was first noticed which subsequently proved the characteristic feature of the king's illness, and, in Dr. Liljewalch's opinion, "brought him to his death." The first trace of this nervous disease, says Liljewalch, "manifested itself long since, although it was not until the last six or eight years of his life that, as we have seen, it occurred with more definite and at last with such threatening symptoms. No one who had an opportunity of observing him during a long period in his daily intercourse, could avoid being amazed at the very extraordinary power the king always exhibited of retaining in his memory the most varied details, or could cease admiring" (really one could imagine that some few could achieve this, however impossible it might seem to the courtly Liljewalch) "the rapid apprehension, the unerring judgment, and the singular clearness of statement which were exhibited whenever he spoke. But at the same time he could not fail to recollect how the king sometimes, in the middle of a conversation to which he was directing all his attention, would of a sudden appear to be abstracted, and would actually transfer his thoughts to some other subject on which unless he might be disturbed, he would allow them to rest, usually only for a few moments, but sometimes for many minutes, after which the conversation would be resumed as if it had not been interrupted. The peculiar expression of the king's features—particularly his look, assumed on such occasions, and the spasmodic state, or the involuntary movements which at the same time took place in one or other part of his muscular system—render it probable that this distraction, which at times was of frequent recurrence, was due to an incipient affection of the central organ of thought. This symptom, referable to the most important organ of the nervous system" (the care and ingenuity with which the court physician avoids any direct statement that the king's brain was affected is worthy of all praise) "was of late years accompanied, as has been already mentioned, with increasing weakness in the muscles of the lower extremities, and with uncertainty in the combination of movement, probably depending on a commencing organic change, either in the organ alone on which the power of motion depends or else in that by which the co-ordination of movements is effected." The king himself was not misled by the phraseology in which the court physicians endeavoured to cloak the fact that his brain was disordered. "Incapacity to discharge his royal functions now brought on a deep melancholy, and the king, even in the commencement of his illness, expressed his conviction of its incura-

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bility." The strength of the body failed more and more as "the organ on which the power of motion depends" became more and more diseased. "The lower extremities, the muscles of which were always weak, began to totter under the weight of the body, and at the same time the power of combination for the motions of those parts was impaired, and the king was troubled with vertigo, particularly accompanying the movements of the head, and with vomiting, which symptoms, in combination with diminution of strength and the occurrence of involuntary muscular spasms, indicated the existence of a more deeply-seated affection, probably a softening in the central nervous system." (One could imagine that as, of old, Spanish courtiers adopted the conventional hypothesis that a Queen of Spain has no legs, Dr. Liljewalch held that the Kings of Sweden, and "royal personages" generally, have no brains). The means employed to combat the disease produced no good effects; "the paralysis, which commenced in the lower extremities, gradually increased, and after the king, feeling his inability any longer to fill the high position to which Providence had called him, transferred into the hands of the crown prince the government of the United Kingdoms, his deep melancholy gave way to a progressive indifference, even for those things which in his health he had regarded with the most lively interest." The rest of Dr. Liljewalch's account relates to the gradual failure of King Oscar's powers, mental and bodily, and is too technical to be quoted *verbatim*. It is noteworthy that the power of speech began to be affected early during the progress of the disorder, and later was lost altogether. From this we should be led to regard failure in the power of verbal expression as a later, and therefore a more alarming, symptom of cerebral mischief, than diminution of the power of fixing the attention. The *post-mortem* examination of King Oscar revealed extensive disorganisation of the brain.

A case somewhat similar to that of King Oscar is thus related by Dr. Forbes Winslow:—"A gentleman connected with the Stock Exchange was suspected to have disease of the brain. His symptoms were as follow: general muscular weakness, occasional paroxysms of severe headache, slight paralysis of the superior palpebræ and of the left eye, occasional sensation of numbness in the right foot. The mind was not apparently at all impaired. He continued, up to the period of my being consulted, fully competent to discharge all his commercial duties, attended to his accounts, and wrote letters of business with his usual ability and clearness. His brother informed me that at times he was greatly *ab*stracted and *dis*tracted; that whilst engaged in conversation, he would suddenly pause put his hand to his head, and appeared vexed with himself at having lost all consciousness of what he was saying. This symptom was observed *two* years before any question arose, or suspicion existed, as to the state of the brain! The family, judging from the subsequent progress of the case, were of opinion that the cerebral disorder was first exhibited by the sudden lapses of thought to which he was subject for many years previously to the manifestations of other and more unequivocal symptoms of brain disease. Such, also, was my opinion. . . . . In about a year and a half he died, quite paralytic. Considerable organic disease of the brain was discovered after death."

In another case, which also ended fatally, an Irish barrister, three years before an attack of acute mania, was observed to stop occasionally whilst addressing the courts of law, as if for the moment lost. "So marked was this symptom, that a professional friend, often associated with him in the conduct of legal matters, considered it his duty to direct the attention of the gentleman's wife to the fact, considering that such attacks of mental distraction, on occasions when it was of essential importance for the mind to be in a state of continuous activity, looked suspicious, and, according to his judgment, were not consistent with a healthy state of the brain." About two years after this peculiarity had been noticed, this patient experienced a slight epileptiform seizure whilst at his chambers, during a very hot day in the month of July. "As this attack was considered to have been one of syncope, and to be caused by the then high state of the temperature, little or no notice was taken of it. Previously to travelling on the Continent, he had been working unusually hard, eating and drinking very sparingly, sitting up late at night, and rising early in the morning. In fact, he acted with great indiscretion and imprudence, and the result was an acute attack of brain disease, affecting the mind, a fortnight after his arrival in Paris." In this case, the *post-mortem* examination revealed the existence of chronic disease of the membranes of the brain—mischief which seemed to have lasted for a considerable time before death.

As we have already explained, it is not so easy to find illustrative cases of the less alarming forms of distraction. Even in cases where serious mischief has followed these slighter mind troubles, the symptoms immediately preceding such serious illness have commonly been of a more marked kind, and these alone have usually been regarded as really belonging to the case. Nevertheless, all who have given careful attention to mental maladies, can speak of instances in which the less serious forms of distraction have been noticed early in the progress of cerebral disorders; so that though they need not alarm those who note them in their own case, they should not be neglected. They are always signs that the mind wants rest, and they may be signs that some more specific remedy is required, which can be readily determined by noting whether rest brings relief. "I am anxious," says Dr. Forbes Winslow (and it could be wished that throughout his valuable work he had been similarly careful to avoid occasioning unnecessary alarm), "to attach no undue importance to this evidence of morbid intelligence, but I cannot close my eyes to the fact that a debilitated power of attention is a prominent symptom in the early stage of cerebral disorder. Cases of incipient brain disease have occurred in which patients have, previously to other symptoms, lost all ability to read continuously twenty lines of a book without a painful effort of thought." It will be noticed that Dr. Winslow here puts distraction as a phenomenon preceding, in cases of cerebral disorder, the loss of memory: albeit, we believe that had he had the means of ascertaining the precise progress of mental disorder, in cases where he supposed this to have been the case, he would have found that the memory had begun to go in the first instance. "If," he proceeds, "there be impairment of attention and debility of memory, it is illusory for the patient to imagine that he is able, until his *physical* condition of ill-health is attended to, by repeated and persevering efforts, to resuscitate these prostrated powers. In his attempt to do so he still further taxes the morbid state of these faculties" (meaning, apparently, that he overtaxes the faculties and makes their state still more morbid), "and, instead of invigorating, still further debilitates, and often entirely extinguishes his intelligence." This caution cannot be too carefully attended to. Returning to the analogy between bodily and mental powers, which we touched upon at the outset, we may compare the power of attention to actual muscular strength,—as the power of memory may be compared to skill in mastering such and such feats of muscular dexterity, and acquired mental knowledge to the various athletic exercises which a man has learned to

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achieve. Now if an athlete finds that his bodily strength is unequal to a task which has hitherto been well within his powers, he would not think (if he were wise) of trying repeatedly to achieve the muscular effort which he has found too much for him. Or (extending the analogy to other ways in which the power of attention may fail) if an athlete finds that he is unable to continue some muscular effort so long as usual, he does not compel Nature to achieve the task which for the nonce has become too great for him. In either case he perceives that for the time being he is not himself, and, by rest or change of some kind (diet, mode of training, or the like), he seeks to restore his powers. At any rate, if he is so unwise, in either case, as to endeavour to master Nature, he increases the mischief, and may entirely lose the powers which had been weakened, and might otherwise have been soon restored, or might at least have been saved from further weakening. So, remembering how close in reality is the analogy between the mental and bodily powers, we can well believe Dr. Forbes Winslow, when he tells us that when the attempt to fix and concentrate the thoughts requires a continuous, painful, and vigorous effort of the will, "serious and irreparable injury may be done to the delicate organisation of the brain and mind by injudicious attempts to exercise, stimulate, and *force* into activity the morbidly flagging and sluggish mental faculties." These symptoms show that the brain is for the time being unfit for sustained action or for intense action, though not necessarily (or even probably) diseased, and that rest is essential to restore its enfeebled energies. Whether such rest should be long-continued or not, will depend on the question whether the symptoms of weakened powers of attention are marked or otherwise, and also in no slight degree on the length of time during which these symptoms, whatever they may be, have been neglected. If they are attended to so soon as they are noticed (in which case they will probably be slight), a very brief rest will generally restore to the mind its wonted energies. Many a man who, in the midst of prolonged and arduous mental exertion, has noticed signs of flagging in his power of attention, has found in even half-an-hour of sound sleep a remedy more effective than a three months' rest would be after such signs had been neglected during several successive weeks of mental labour.

Some physiologists assert that defective speech, the next symptom which we have to deal with, has been the first symptom noticed in cases of cerebral disorder. Dr. Forbes Winslow says:—"The first evidence of approaching apoplexy and paralysis is occasionally a sudden loss of speech." This may have been the first symptom noticed, but we question very much whether it has ever been the first symptom which has existed.

We ought to distinguish, perhaps, here, between defective speech and defective power of expression (by words indicated otherwise than by actual articulation). In fact, an important distinction exists even between the loss of the power of articulation and the affection of the vocal organs indicative of cerebral disease. Here, however, we consider generally the impairment of the power of linguistic expression which usually precedes serious mental trouble, and is often enough noticed where rest only or change of diet is necessary as a remedy. Usually, however, this symptom is serious. Indeed, one writer on the subject of cerebral disease remarks that it is a most unusual circumstance for the symptom to exist without being followed by acute cerebral mischief. Possibly the remark refers only to the absolute loss, whether for a short or long period, of the power of expressing ideas by language, spoken or written. That the power of expression may be affected, and even for a time affected seriously, while nevertheless there is no serious cerebral mischief, is within the experience of most persons who have occasion to exercise this power freely. The symptom, like others we have dealt with here, is one to be noticed, and its warning voice should be heeded early. This done, there is usually little occasion for alarm, startling though some of the stories now to be related may appear.

Dr. Winslow relates that "a literary gentleman, whose vocation in life was that of a public lecturer, noticed for nearly eight weeks before he was seized with paralysis, that occasionally whilst speaking he lost for a second or two all power of articulation. This occurred on five or six occasions previously to an attack of decided hemiplegia. This patient had taxed his powers of mind to their utmost by lecturing twice, and often thrice, a day*; but independently of this amount of literary labour, he had been exposed to much anxiety respecting family matters, and this had produced restless, and, in some instances, sleepless nights."

INTELLIGENCE IN ANIMALS.

LET us next examine a few cases in which animals have done things which they have seen done by the persons with whom they live, and more or less obviously with the object of obtaining the result which they had observed to follow from such actions. For this would seem, if the animal can be clearly shown to have had such a purpose, to be distinctly the result of reasoning. Monkeys may or may not reason when they imitate actions which, when performed by themselves, are of no advantage to them, or are even mischievous. Indeed, it is not improbable that they suppose their human fellow-creatures would not perform such actions except for a useful purpose, though what that purpose may be they may have no conception. But whatever opinion we may form on this point, we can have, it would seem, no room for rejecting the belief that an animal has reasoned who performs an act demonstrably for the purpose of producing a certain effect, such as he has observed to follow when human beings have so acted. Now in some of the cases which follow, this does seem to be most clearly made out.

A writer in *Nature* gives the following case:—"My sister, who lives just opposite to my own house, possesses a cat (now about thirteen years old), whose intelligence is very remarkable. He has a habit of making use of the knocker of a side door, which is just within his reach as he stands on his hind legs, whenever he desires admission. A single knock is tried in the first instance; but if this is not answered promptly, it is followed by what is known as the 'postman's knock;' if this is not successful, trial is then made of a scientific 'rat-tat' that would not disgrace a west-end footman. I should say that 'Minnie' holds the knocker in his paw as we should hold it in our fingers, and not by simply tipping it up. How far this practice involves 'abstract reasoning,' I will not say, but something like an approach to it is suggested, for he was never taught to knock at the door, and adopted the habit some three years ago, evidently to gain admittance, very often to the annoy-

* The writer of these lines has lectured twice a day for a week, filling up four or five hours of each day with literary work, without feeling any effects which seemed to suggest that he had taxed his powers of mind to their utmost. But, on the other hand, he has noticed that after lecturing only once a day, or even only four times a week, while travelling great distances each day, several of the symptoms of incipient cerebral mischief have appeared; and even less lecturing, accompanied by much mental anxiety, has caused such symptoms to appear.

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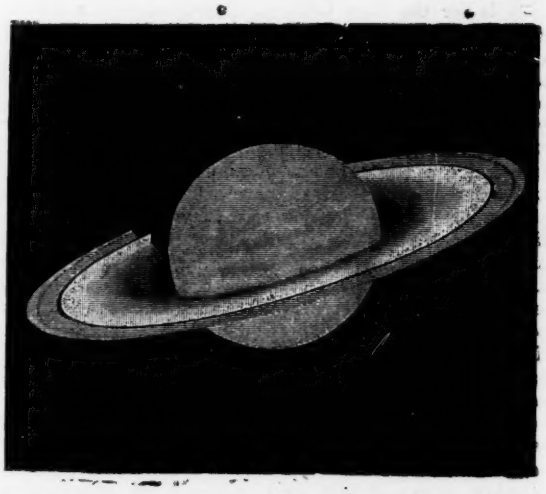
ance of my sister's family, who have occasionally been disturbed in this way at unseemly hours." The rest of the letter has no bearing on the subject we are upon, but it is too amusing to be omitted. "I should be sorry," says the writer, "in thus referring to the sagacity of poor pussy (who is now also somewhat feeble), to reflect upon him by noticing some other of his peculiarities, one of which is his fondness for a little brandy-and-water, and other alcoholic stimulants." It would be, perhaps, to inquire somewhat too curiously to ask whether this story shows that the fondness for stimulants is associated with an advance in reasoning power, or whether, perhaps, Minnie's brain was aroused to abnormal activity by the tippling in which alone (we may assume) he was indulged by his mistress. The point established by the story is that in some cases—at any rate, as in animals so low in cerebral development as cats—the consequences of a certain action are observed and remembered, the action being repeated by the animal when he wants those particular consequences to follow. This cannot be explained by any theory of mere instinct.

In the last story, the cat was an old one, and though this does not modify the conclusion to be deduced from the animal's behaviour, yet it in some degree diminishes our estimate of the activity of Minnie's reasoning power. In the following case, a young cat showed equal intelligence:—"I may mention a case," says the writer, "of a kitten about half-grown, having mental reflection of some sort. I was sitting in one of the rooms at a house where I was stopping in Somersetshire, and hearing a knock at the front door, was told not to heed it, as it was only this kitten asking admittance. Not believing it, I watched for myself, and very soon saw this kitten jump on to the door, hang on by one leg, and put the other fore paw right through the knocker and rap twice. The knocker was an ordinary shaped one, fixed in the centre of the door half way up; the top part of the door was glazed. I saw this performance dozens of times afterwards, and often used to put the kitten outside to see it done. It was never known to knock when anyone stood in the garden, but if one went indoors and shut it outside, in a few minutes came the usual knock. A sister kitten to this one was never known to knock, but sat on the doorstep and entered when the door was opened, and in nine cases out of ten the knock was successful. The kitten was never taught in any way; it would knock at both front and back door."

In the following case, the object of an animal's action in such cases was tested by an experiment, but the evidence is less satisfactory in one respect than that afforded by the two previous cases, the animal having been taught the action:—"A small English terrier belonging to a friend," says the narrator of the story, "has been taught to ring for the servant. To try if the dog knew *why* it rang the bell, he was told to do so while the girl was in the room. The little fellow looked up in the most intelligent manner at the person giving the order (his master or mistress, I forget which), then at the servant, and refused to obey, although the order was repeated more than once. The servant left the room, and a few minutes afterwards the dog rang the bell immediately on being told to do so." Here it is to be noticed that the dog did not ring the bell (as, in each of the preceding stories, the cat knocked at the door) to get some end of his own accomplished. He rang to save his master or mistress trouble. And the fact that he had been taught to ring for this purpose, although making the act itself less obviously a sign of reasoning power than the cat's action in knocking at the door, makes his refusal to ring when told to do so a more manifest evidence of reasoning than it would otherwise have been. If the dog rang for the servant because of some advantage he always gained from the servant's coming, it would have been natural enough that he should refrain from ringing when the servant was in the room. But his refusing to do what he had been taught to do, at the risk of offending his master or mistress by such refusal, makes it absolutely certain that he had clearly recognised the object which was to be attained by ringing the bell.

THE PLANET SATURN.

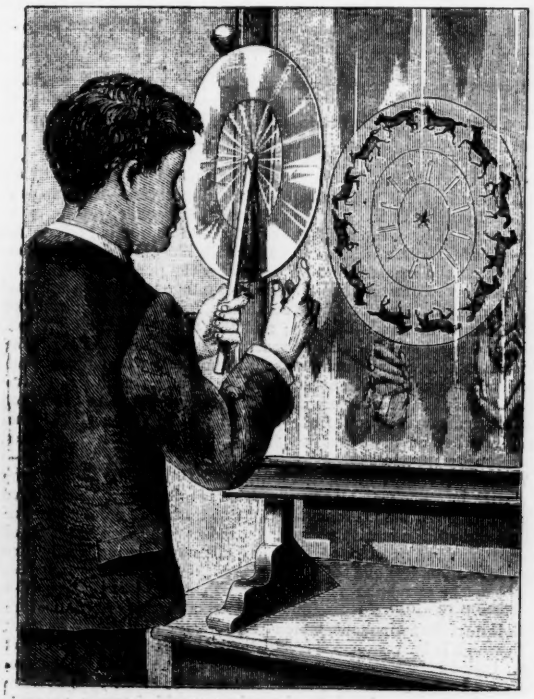
ALTHOUGH the ringed planet is passing away from the position where it shines most brightly, and being nearest to the earth, is, on the whole, most favourably situated for observation, yet, as he passes away from this position he shows certain features of interest which are either less favourably seen, or not seen at all when he is nearest to us. Just as the full moon shows no shadows, being seen from the earth when it is between the moon and the sun, so the shadow of the planet Saturn on his rings is less invisible when Saturn is in opposition (as it is called) to the sun, that is, when the earth lies on, or very near, a line drawn from the sun to Saturn. But when the earth has, by her more rapid motion, passed away from this position, the steadfast



shadow which, "as the planet whirls, sleeps on the luminous ring," is well seen. This shadow is an interesting object of telescoqic study, because, instead of presenting at all times those uniform outlines which the laws of perspective teach us should be presented by the shadow of a spheroid on a plane, or nearly plane, surface, the outlines are often very cunningly distorted. Thus, in the accompanying picture, we have a view of the shadow as seen by Trouvelot, an excellent American observer, with the magnificent 26 in. telescope of the Washington Observatory, and this shadow is so distorted that one would say it was entirely "out of drawing" if one were not certain that Trouvelot depicted correctly what the perfectly trustworthy and most powerful telescope he employed, showed him. We would invite telescopists to examine the planet carefully during the next few weeks, and note any peculiarity of shape which the shadow on the ring may present. We shall be glad to indicate, for comparison with drawings which may be sent us, the true shape which, according to the laws of perspective, the shadow should have had at the epoch of the respective drawings.

THE MAGIC WHEEL.

WE had hoped to present our younger readers this week with a drawing of a trotting horse in the various positions successively assumed by the animal (as instantaneously photographed), for use with the ingenious instrument illustrated in the accompanying cut. But, on carefully examining the picture in the *Scientific American*, we found that there was an error which would have caused the picture to produce an imperfect illustration of the horse's action. Twelve positions had been taken from the photographer's series without its being noticed that the last two were almost exact repetitions of the first two (in other words, a complete double



step was illustrated in the first ten pictures). The delay caused by the corrections prevents us from giving the picture this week, but next week we shall have a set of ten positions of a trotting horse, arranged for use as in the accompanying figure, illustrating a highly ingenious method for avoiding the difficulties involved in the construction of a zoetrope. We shall later give a series of views of a galloping horse. In the meantime we leave our younger readers to puzzle out the meaning of the accompanying cut, and in particular to find out how it is that the various parts of a properly-constructed zoetrope are provided for here by so simple a construction.

PRIMARY COLOURS.

IT is impossible to construct a consistent theory based on three primary colours, whether the three be the older set—blue, yellow, and red, or violet, green, and red—the newer set of the theory considered by some to have been established by Clerk Maxwell in his paper to the Royal Society in 1860.

Clerk Maxwell's paper contains serious errors. He forms equations with different kinds of quantities, implicitly attributing to the units of those quantities values which, regarded relatively to each other, are purely accidental or arbitrary, and his results are, consequently, fallacious.

As is apparently recognised by Rood, in "Modern Chromatics,"-a correct and complete theory of colour vision ought to enable us to construct a circular diagram of colours, with complementary colours diametrically opposite to each other, and with the colours distributed with uniform gradation round the circle, and in accordance with their true relations to each other. Now, such a diagram cannot be constructed on the assumption that the primaries are three in number, without assuming certain colours, or combinations of colour, to be complementary, which are proved by actual experiment not to be so. The assumption also involves the absurdity that a colour can be (in a sense) complementary to itself; or in other words, that two diametrically opposite colours or combinations of colour which are complementary to each other may each contain the same colour as an ingredient.

When proceeding to arrange colours in a circular diagram, we have first to classify them. For this purpose I take so-called primaries and secondaries together, and for convenience call them simply distinct colours. To the blue-yellow-red theorists I say that to my eyes green and violet are as "distinct" as any of the three, but orange is not to the violet-green-red theorists. I say blue and yellow are as "distinct" as any of the three, but purple or crimson is not. How many "distinct" colours, then, are there to be assigned to equidistant points on the diagram? In my opinion the human mind cannot conceive of more than five colours which are as distinct from each other as red from yellow or from violet, or as blue from green or from violet, or as yellow from green. If, then, there are only five colours of the first class, or of the first and second classes together, it is impossible to construct a theory with three primaries, for such a theory implies three secondaries, or six colours of the first and second classes taken together.

With reference to seeing red in the violet of the solar spectrum, I may mention the case of a person who sees the violet of the spectrum as a dim grey only, and yet, when two spectra overlap, so that the red end of one combines with the blue part of the other, he apparently experiences the same sensations of violet and purple as normal-eyed persons.

It is held by Helmholtz and others, and I think there can be no doubt of the fact, that mentally we cannot really distinguish in any colour-sensation any components, but only a single resultant sensation. We may experience a sensation which may be called pure as regards its colouredness; for example, we may experience the sensation of a green, which inclines neither to yellow nor to blue, but it is quite certain that for a normal-eyed person it is impossible for light to act on the eye in a perfectly simple or pure manner. In this sense a perfectly pure colour is not obtainable even from the solar spectrum itself, however much it be dispersed, or however narrow a portion of it be taken. To explain my meaning, I will suppose separate nerve fibres of the retina are sensitive to the different primary colours, whatever they may be; then, what I assert, and can prove, is that no part of the spectrum, however small, acts on a single fibre (excepting, perhaps, at and near the extreme ends of the spectrum). Assuming this to be true, it follows that experiments, like those recently described by Lord Rayleigh, in which the green and red of the spectrum are combined and produce the sensation of yellow, do not in the least prove that the sensation of yellow is necessarily a compound sensation, or that yellow is not a primary colour. A great deal of the difficulty arising in the consideration of the effects of mixing colours disappears when it is understood that colours neutralise rather than combine with or add to each other, the resultant sensation being one which may be described as a mixture of more or less white or uncoloured light, with as much of the colouredness as is not neutralised. E. H.

Glasgow, *Dec.* 3, 1881.

CHARLES BRUSH, of Cleveland, Ohio, is declared to have perfected a new invention for storing electricity. The design consists of a battery in the same sense as in Plante's and Faure's, but the details are entirely different, and do not infringe upon the rights of either. Mr. Brush uses for his storage reservoir metal plates, so arranged that they are capable of receiving a very large charge of electricity and of holding it for an indefinite time. The storage reservoirs vary in size as desired, may be transported from place to place, and used as desired. Each citizen may then run his own electric light as he pleases; the plates can be put on street-cars, connected with the axles, and made to run the cars without horses, and steam-cars may be ultimately run in the same way. The practical character of the invention is said to be settled, and it is simply a matter of expense, but the details of the methods are not made public.—*Frank Leslie's Magazine.*

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RIGHT-HANDEDNESS.

By James Shaw.

THERE is a difference both in structure and capacity between the left and the right lung. The former has two lobes, the latter has three. Suppose 240 inches of air have been inhaled, about 130 have been taken into the right lung, and 110 into the left. Watch at the same time the right side of the chest, and it will be seen to be more bulged out during inspiration. Meanwhile, the lower ribs, as they recede from an imaginary middle line, are firmly bound by a ligament, or short cord, to the liver. The liver, a heavy organ of about 4 lb. weight, inclines the centre of gravity to the side to which it swings, and the greater expansion of the right lung and the shifting of the liver to the right side tend to shift the centre of gravity to that side.

The heart, firmly attached to the spine and midriff, remains immoveable, but the stomach and spleen incline to follow the liver. They cannot follow the left ribs in a contrary direction, for they are not joined to them. The shifting of the line containing the centre of gravity towards the right has no countervailing-force opposed to it, for although the greater part of the heart and the spleen is on the left side, it is not enough to balance the part carried towards the right by the descent of the diaphragm, during inspiration.

It has been estimated that the viscera of the abdomen and the chest weigh heavier, by about a pound, on the right side than the left. Now it must be plain that if the right side be heavier naturally, and still heavier during the inspiration that precedes effort, the foot that supports it will be more leant upon; and if we lean more upon the right foot, it will afford a steadier basis of action for the right arm than for the left. According to this view, first clearly put forth by Professor Buchanan, there is a mechanical reason for right-handedness. The right leg is first preferred and utilised in action, and upon this preference the right hand and arm come more readily into use, and are then taken up consciously and educated as the skilled limb. No sooner is a beginning made of preference than the muscles oftenest or most strenuously used get stronger.

Violently exercise the right hand and arm, and you might expect that both lungs would inflate to their uttermost. But this is not the case. The right lung is better filled with air in proportion to its capacity than the left. If we exercise the left arm, the left lung is more inflated, according to capacity, than the right. We may even witness the right cheek of a man, violently engaged in lifting a load with the right hand and arm, inflating unconsciously. In some physical efforts, such as throwing a stone, in which the centre of gravity advances from the right, forward, and towards the left, the dilation of both cheek and lung has been observed, passing over from the right to the left. The temptation to prefer the right shoulder, the right arm and hand, in lifting a dead weight, because of the centre of gravity being more nearly over the right foot than over the left, is quite a natural one. So, when a carter puts his shoulder under the shaft of his cart, he prefers to hoist it up with the right shoulder, as having more power in raising it.

But the question may be urged, why are burdens generally carried on the left? Although portable loads are generally placed on the left shoulder, this, instead of being at variance with the mechanical theory, is really a proof of it. When a man has a heavy weight upon his left shoulder, the burden is, in reality, borne by the right rather than by the left lower limb. The body is inclined to the right, so that the mechanical axis passes from the left shoulder to the right foot, and the load is retained over it by the help of the right arm. In the case of burdens, such as fishwives' baskets, borne on the left side, it must be remembered that as the right side is the heavier, these burdens help to restore equilibrium with less of a bend towards the opposite side, and so leave the motion of the limbs less constrained. This is probably one of the causes why a nurse carries her child in her left arm, although we must recollect that, by doing so, she has another advantage, namely, the freedom of the right hand for work.

Professor Ferrier informs us that the brain has a cross action. The left hemisphere governs the right side, and the right hemisphere governs the left side. Therefore, when we see with our right eye, we see with the left side of our brain, and when we see with our left eye, we see with the right side. Now, not only has the right side a mechanical advantage; but it is strongly suspected that the left hemisphere of the brain, which governs the movement of the right side muscles, is, so to speak, a battery of greater power than the right hemisphere. Dr. Boyd made observations on the patients in St. Magdalen's Hospital, and he sets forward as a curious result, that, after weighing separately the hemispheres of 200 individuals, almost invariably the left hemisphere exceeded by an ounce the weight of the right hemisphere. To do so exactly, however, requires great nicety, as there is no definite division between the two hemispheres; and so we are not surprised that in Dr. Wagner's experience the proportion of cases having heavier left lobes was as five to two. In the Report of St. George's Hospital (1869), there is recorded a case of loss of speech and paralysis of the left arm of a left-handed lad, whose brain, after death, exhibited a softening of the right hemisphere. The question of how much the strength and dexterity of the right hand depends on the shape and nature of the brain substance is beset with difficulties; but the balance of the evidence is in favour of the constitution of the brain itself being a reason in favour of right-hand predominance. A reason founded on nature is much more satisfactory than the notion, somewhat prevalent, that right-handedness is a fashion. True, there is a percentage of our fellow-creatures left-handed; and there is a difficulty to account for this peculiarity. But it is not easy to account for many peculiarities equally striking; such as the want of beard in some men; the greater or less number of teeth, toes, and fingers; the heart being found occasionally on the right side; and the transposition of the viscera. Some men can shut one eye and keep the other open at the same time. Others can only do so with difficulty; and others, again, are quite unable to do so. From the evolutionist's point of view, it seems to me as if our destiny were to become more intensely and more generally right-handed than we are. If we go far enough back in infant biography, we arrive at a period when locomotion is chiefly performed by the aid of all four limbs. This is the case with adult apes and monkeys, who shamble along on a plain, or climb more gracefully in the woods, by the aid of all their limbs. With the infant, the difference of internal structure—throwing the centre of gravity to the right—is scarcely perceptible.

It is argued by some writers that it would be a great advantage were we ambidexter, using both hands with like skill. Now, no one doubts that the specialisation of hands for the purpose of grasping, and feet for locomotion, is of more advantage to man, than if he had four hands fitted for both functions. As the child grows older, the difference of hands appears; and this difference, in all civilised countries, is eagerly helped by precept and example. As in playing whist, it is better that partner should have many trump cards and self few, than that each should have an average number; so it is found that in a world where time is so valuable, where art is long and life is short, it is better one hand should be very well educated and the other comparatively neglected, than that each should have a moderate aptitude.

We can go back, in imagination, to the time when the grasping of a stick or stone was all the education received by a human hand. We can suppose the make of the body at that time more symmetrical, as an infant's is with us now. It is like going back to the time when the ancestors of our horses had more of a normal foot—three toes, instead of the one toe of our present steeds. Right-handedness would not be so regular nor so apparent then; just as it is said to be with Fijians at the present day, or, as it has been observed with the African elephant, which has a tusk called the "servant," with which it burrows more freely, but which is not so regularly the right tusk as the working hand is the right one with us. As soon, however, as man combined, either in labour or in war, the necessity for preferring one hand to the other would become apparent. Indeed, the evident advantage of shielding such a vital organ as the heart from wounds, and pushing forward the less vital right side, would incline men to place the shield in the left hand and the sword in the right. At all events, the thickening of complex circumstances would be unfavourable to a state of unstable equilibrium. When once the movement of preference began, everything would tend to strengthen it. Many of the implements by which man conquers nature would require to be made either to suit the supinating motion of the right hand or of the left.

The slightly stronger side would gain the day, and become the more apt and stronger after it had gained it. Now, since it has become an accomplished fact that screws, gimlets, scissors, scythes, &c., are all made for right-handed men, he who would educate us to the ambidexter must have two handles on every door, two methods of winding up every watch, Janus-shaped carpenters' benches and printcutters' gauges, duplicate sets of screw-nails, scissors and scythes.

Not only is the right hand the most dextrous, but, as far as I have extended my observations, in those cases in which there is a difference in the strength of vision between the right and the left eye, the advantage, more frequently, lies with the former. It may be thought that investigations of this kind are unpractical, but it will not appear so when it is stated that they have been the means of discovering serious differences in the organs of vision of the same individual, which drawbacks can be greatly modified by the spectacles of the optician. The relief, in reading, given to such a lop-eyed person when he has got a lens suited to either eye, is so great that, when once discovered, it is never forgotten. It is wonderful

how late in life some persons have been in detecting such inequality of vision. Indeed, there is a case mentioned by the younger Herschel, of an individual not knowing of complete blindness of one eye until advanced in years. When there is a weak one and a strong, it is generally the weak one that is most liable to disease, from its unconsciously straining to share the labour of reading, painting, or engraving with the other.

EARTH TREMORS.

(From the *Times*.)

ONE day during the past summer, at the end of a long uphill beat after the partridges, I threw myself breathless on the ground, and on my back waited for the others to come up. As they drew near, five or six strong, tramping heavily through the turnips, I was struck by an apparent tremor of the earth beneath me. It was shivering like a jelly—or I was; for a moment I was in doubt which. Spreading out my hands upon the surface, and lying as close and flat as I could, I was soon made sure that the tremor was really in the earth and not in me. It grew more and more distinct, keeping time with the tramp of the walkers. When at last they reached me I told them of their Neptunian feat, and, making them jump altogether a few yards off was gratified to find that I could thus bring about a very respectable earthquake at will. The motion was very peculiar, and I can well believe that a queasier stomach than mine would soon be conscious of something very like a *mal de terre*. We examined the structure of this skipping hill, but found nothing that helped us much to an explanation. It was mainly made up of a thick cap of gravel on a base of red sandstone, and so was not likely to contain anything like a high-arched hollow or concealed morass within.

This vivid little experience made me readier, perhaps, than some to accept the striking statements about earth-shaking made by the brothers Darwin at the York meeting of the British Association. Especially was I prepared to give credit to what they quoted from the Astronomer Royal about Greenwich Hill and the Observatory. He wrote:—

"In the old times of Greenwich Fair, some twenty years ago, when crowds of people used to run down the hill, I find the observers could not take reflection observations for two or three hours after the crowd had been turned out. . . We do not have anything like such crowds now, even on Bank holidays, and I have not heard lately of any interference with the observations."

There is as little foundation for the calumnious hypothesis that the observers whose reflections were thus agitated had been visiting the fair themselves as for the suggestion that the above experience of my own took place after luncheon. No, the truth is, the solid earth is a very elastic solid after all, and Greenwich Hill and the Observatory and all that it contained were trembling like my Highland knoll. The *howdah* of the Atlas-elephant that stands on a tortoise is a rather ricketty structure, and quakes with every jog of the Titanic beast. But is it not being tugged at by every petty planetoid, pulled from its path by every planet, heaved all awry through its yielding bulk by sun and moon in their courses? It is; but over and above these longer, graver motions, there are incessant tremblings and quiverings in quick periods measured by seconds or less. This unlooked-for sensitiveness to small stresses, this incessant vibration when all obvious disturbing causes are eliminated, are the new facts that the Darwins have so strikingly brought out. How solid rock and massive piers of stone warp under heat and cold like unseasoned wood, how a wide stretch of ground may swell and rise for hours together after a little water has been poured on it, how the passage of a train miles away, or the pressing of a finger on the ground near at hand, may be enough to deflect the plumb-line to a visible degree—these and many other new phenomena are detailed in the full and most interesting preliminary report on the Lunar Disturbance of Gravity handed in to the Section of Physics by the ingenious brothers.

The title reminds us that, as so often in science, it was in looking for one thing that they found another. Every one knows that as the earth pulls the moon round in its monthly orbit, so, too, the moon pulls the earth and everything upon it. If a plummet be hung up right under the moon, so to speak, the earth is drawing the bob downwards, the moon very much more feebly pulls it upwards. The result is that the bob weighs a trifle lighter than if the moon were abolished. Thanks to the moon, the string is less severely strained. If the moon be not right overhead, but down a little towards its rising or its setting point, the bob will be a little drawn aside out of the straight and the plummet will no longer give a true plumb-line. As the moon rises, crosses the sky, and sets, then the direction of the plumb-line will change through a small angle. Of course, even when no moon is seen, its silent influence must be felt, and the plumb-line will return to its position by the time the moon is ready to rise again. How small the change really is we may gather from the fact that with a plummet 300 yards long the travel to and fro of the bob could scarcely in this country reach a thousandth of an inch. This is what is meant by the lunar disturbance of the direction of gravity; and there must, of course, be a solar disturbance also, the same in kind, but naturally very much smaller in amount. To investigate these disturbances experimentally clearly calls for refined skill and very delicate apparatus; but Sir William Thompson, to whom instrumental difficulties are always but child's play, in suggesting the investigation three years ago, had in view the detection of an influence still more recondite and refined.

I have said that the moon, in pulling aside the bob of the plummet, pulls also on the earth beneath it. If the earth were perfectly stiff and unyielding, this pull could have no effect on the deflection of the plumb-line. But if, as we have reason to believe, the earth yields like a great viscous mass to great stresses as well as to small ones, a hump of solid earth—a land-tide—will travel round the globe in obedience to the moon's attraction. This hump in its course will pass under the suspended plummet, and the actual deflections of the plumb-line as observed will no longer agree with those reckoned on the supposition that the earth is rigid. If we had an instrument, then, by which the minute aberrations of a carefully-suspended pendulum, isolated as far as possible from all local disturbance, could be magnified up to the point of visibility, we should have it in our power to settle some very pretty points in the physical theory of the world. Such an instrument, after various trials and failures, the Darwins have erected in the Cavendish Laboratory at Cambridge.

A massive stone, weighing three-quarters of a ton, is bedded in a pit upon the native gravel. It is surrounded by a trench, a foot wide, to isolate it completely from the floor and the building. The pendulum is a massive cylinder of pure copper, hung, by a brass wire about a yard long, inside a hollow cylindrical copper support, that rises from the stone. A tiny galvanometer mirror is hung by two fine threads, one of which is fastened to the bob, and the other to a projection of the fixed support. This suspension is so arranged that any movement of the bob displaces the mirror to a much greater degree. A ray of light is sent from a distant lamp on to the mirror, and thence reflected to a scale seven feet away. The magnification resulting from this double process is something like 50,000 times. To still and quench accidental tremors, the hollow copper cylinder is filled up with a mixture of spirits and water. It is a fact, made out by physicists that a boiled mixture of gin and water is much more viscous and clogs the motions of bodies immersed in it much more effectually than either the neat gin or the simple water. Further, to ward off the effects of external changes of temperature, the whole instrument is immersed in a tank of water resting on the stone; and lastly, after the precedent of the Tishbite, the surrounding trench is also filled up with water. Thus protected, the apparatus might seem sufficiently cut off from local influences, but as a fact its sensitiveness is now so great, that the observation has to be carried on in another room by means of a window and a telescope. Standing in the room itself 16 feet away, it is enough to shift your weight from one foot to the other to cause the speck of light to run along the scale. The same result follows if you press steadily with your fingers on the stone edge of the trench, but you may strike a good sharp blow even on the stone base without effect. It is the distortion of the soil by slight, steady pressure that is transmitted through solid gravel and stone, and shows itself as a microscopic deviation of the pendulum. Such being the case, the instrument should be delicate enough, in all conscience, to determine lunar and even solar disturbances in the direction of gravity; but, unfortunately, having got so far we seem almost to have done too much. When regular series of observations are made it is found that the pendulum is hardly ever steady. The image on the scale dances about incessantly. The ground is never really still. Some days it may be quieter than others and generally there is evidence of distinct diurnal periods, but the minor zigzags constantly interrupt, and at times reverse for an hour together, the slower march northwards or southwards. These tremors have been hitherto so persistent and so wildly irregular, that for the present, at least, the prospect of unravelling from them the perturbations due to the moon does not seem very near. Mr. George Darwin talks of the probable necessity of building a gravitation observatory at the bottom of a mine. There, it may be hoped, the railway train and the market cart will cease from troubling, and the plummet, save for the steady paces of the moon, will be at rest. The work of examining and observing these tremors of the surface is, however, still going on at Cambridge, and already several sharp seasons of microscopic earthquake unsuspected outside have been noted. Sometimes a very storm of tremor breaks out, for which no sufficient local cause can be traced.

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Even so far the outcome of these experiments may prove of high value to practical astronomers. The piers on which their great telescopes turn are built of solid stone, hitherto regarded as the material most insusceptible to change or disturbance. The Darwins have shown that such piers are really most sensitive to inequalities of temperature and to small stresses. They yield and warp to a most unexpected degree. Their bad conducting power is responsible for this in part, and it is fruitfully suggested that it might be well to plate the piers with copper and to swathe them with flannel. Astronomers, who, to their vexation, have to redetermine the level of their instruments from hour to hour, and who have long suspected the occurrence of microscopic earthquakes, will take note of this practical hint. They will make ready use, too, of the observation here recorded as to the effect of the observer's own weight. They will think more of the drainage of the soil around their instruments after the observation on the irregular and long-continued swelling of the ground that results from the percolation of water. Meanwhile, the British Association and Cambridge may be congratulated on the new and valuable field of work thus opened out under their auspices, and especially on their having enlisted the services and energies of two workers who so worthily keep up the tradition of an honoured name.

BREATHING.

By Dr. J. Mortimer Granville.

(*Abstract.*)

EVERY act of life, every movement, every thought, involves the final use of some particles of the body. In the great majority of instances the material used cannot be used again, and must be disorganised and removed. This is effected through the agency of the blood, which brings the materials of food within reach of the living cells of which every tissue of the body is composed. These draw nourishment from the blood, just as the plant takes up material nourishment from the earth through its rootlets. Side by side with this process of feeding and growth, and an indispensable part of the process, is the interchange of elements—oxygen, hydrogen, carbon, nitrogen, and the like. In short, the vital process is in a large measure chemical, and the oxydising agent—oxygen derived from the atmosphere—is the most potent agent and factor in the production of the general result. If the supply of this agent is not sufficient for the vast purposes which it is required to effect, the animal must suffer a diminution of health, and in the end die. It is plain, therefore, that the phrase "breath of life" is full of the deepest significance. If the animal cannot breathe—using that term with its broad meaning—it must cease to live. It follows that the first concern of the living being, for himself and other living beings, should be to secure a full and fresh supply of pure air. In the case of children, this is especially necessary, for the obvious reason that the chemico-vital changes of structure in their organisms are more active and persistent than those which go on in the adult body. The child is growing in bulk, as well as constantly using up the materials of its body and requiring to replace them by new. The result is a large, continuous, and inexorable demand for copious supplies of fresh air. How is that demand complied with in the majority of cases? Growing children ought to live in the open air; but we mew them up in schoolrooms and confine them to the house on the smallest pretence of weather or indisposition. When a child is ill, its systemic demand for air is not diminished, but rather increased, as is plainly shown by the quickened pulse and breathing. Bad weather is no excuse for the confinement of children indoors. The danger of "cold" is increased by this treatment. Children are made delicate, and susceptible to the depressing effects of sudden or great changes of temperature, by the practice of calling or keeping them indoors for every shower of rain or cold wind. They are also rendered generally weakly by wrapping-up. Later on in years the requirement is very much in proportion to the activity. But, even in a state of rest, the need for oxygen is considerable. If health is to be maintained, it must be in excess of the actual chemical requirements. In truth, the more air of the purest description which can be taken into the lungs the better. Wind is, as a rule, an advantage, because there is less chance of the atmosphere we inhale having stood stagnant over bad soil, or around sources of poisonous or deleterious exhalations, and thus contracted pollution. Breathing bad air is disastrous. The "stifling feeling" and "headache" which are so commonly produced by sitting in a public meeting, are the immediate and more pronounced effects of breathing bad air; but, long before these inconveniences are consciously experienced, and even when they are entirely absent, harm is being done. The robust may not feel the effects, but they too are injured, while the weakly are enfeebled, and the seeds of disease are sown, and will probably spring up later on, and cause trouble of some kind. Nature's preventive remedy for disease, whether in the individual or in the multitude, is a bath of pure air. *The Estates Roll.*

MAN'S PROPER FOOD.

LONG before reading Dr. Carpenter's articles in Knowledge, I had believed that, as a race, we are prone to eat more meat than is necessary. I must, however, protest against Miss Kingsford's argument, which, put baldly, is this:—

"Men and apes are closely akin; apes eat fruit and herbs only, therefore men ought to eat fruit and herbs only."

I cannot, however, see why it is desirable for men to go out of their way to assimilate themselves to apes, and I even think it possible that the divergence of the human from the ape stock began when men became omnivorous. I cannot assent either to the validity of the arguments derived from the animals mentioned by Miss Kingsford and in your article. I say that the wolf is incomparably superior to horse, mule, or camel in endurance, and I would myself gladly back either a lion or a tiger against a gorilla. There may be no flesh-fed animal equal in strength to the rhinoceros, and the other grass-fed animals mentioned are also grand specimens of bulk and strength (and often too of unwieldy inertness) but, *weight for weight*, they cannot compare in strength or activity with the carnivorous animals. Were the vegetarian Indians, who became intoxicated from eating meat, equal in stature, strength, or intellect to the omnivorous European? I guess not; it does not appear indeed that they were not South American Indians, some tribes of which are scarcely human. And that even a purely flesh diet may not be prejudicial is, I think, pretty well shown by the physique and strength of the Sioux and some of the other sufficiently fed tribes of North American Indians. I have lived with them in the buffalo-hunting season, when they and (after my biscuit was done) I too practically lived on buffalo meat only, and if I had not seen it in them, I could not have believed in man's having such wiry endurance; whilst for myself, I can say that, though blessed ordinarily with health and strength beyond the average, I have at no other time known either in anything like the perfection in which I enjoyed them then. Of course, the active life in the open air accounts for much of this, but the diet must, at least, have been wholesome. Personally, I believe in a mixed diet, but I also believe that man's capability of eating *anything* is one great element of his superiority to the beasts of the field. Certainly his adaptability to any climate is owing to that capability. Are the northern regions to be depopulated on the ground that, as there are no fruits and herbs there on which Miss Kingsford's apes can live, man also has no right to live there?

Practical.

CALLAO "PAINTER."

ON approaching Callao in a steamer, at a certain season in the year, the traveller suddenly becomes aware of an unbearable stench in the cabin and everywhere else on board; he naturally asks "what is the matter,"—he is informed "it is the 'Painter,'" the traveller, not yet knowing what really causes the vile smell, wishes "the painter would clear out with his smells." The next thing to be noticed is that the *white paint* on board becomes blackened. If the person who has observed the offensive smell for the first time, as well as the gradual blackening of the paint, has any knowledge of chemistry, he at once sees the cause of mischief, viz.: a great excess of Free Sulphuretted Hydrogen in the atmosphere—this is really the case, the air smelling abominably strong of "rotten eggs"—*i.e.*, H_2S.

If he now looks at the sea around him, he notices that the water has a yellowish milkish appearance, showing the presence of sulphur in the water—anyone who has seen Harrogate Sulphur Water will see what I mean, for the cases are similar.

His next thought is naturally what causes this singular phenomenon.

In answer to his question to those on board, "are you troubled with earthquakes at this time on land (Callao) and sea?" he is told that such is the case.

That earthquakes are felt at this time, the traveller, whether scientist or not, has rather a questionable gratification of finding out for himself before he has been long in the neighbourhood of the "Painter." That some of these earthquakes are serious occurrences our Geographies show us, though nothing is said about the "Painter."

The conclusion I have come to is one which anyone else would come to respecting this disagreeable local phenomenon, viz.:—that at a certain season of the year a submarine volcano breaks out impregnating the sea with its sulphurous vapours, then when the sea has absorbed its share, the air becomes filled with the gas.

XUM

It seems hardly necessary to explain why the white paint should become black. It is simply due to the action of the gas—already alluded to above—on the white lead of the paint, sulphuretted, hydrogen having the property of changing the white lead or oxide into the sulphide of lead.

Bitumen is, I believe, thrown up onto the shores of Callao, just the same as it is on the shores of Mexico, where it soon becomes a hard mass. F. C. S.

COLOURS OF ANIMALS.

PERMIT me to reply to "B. Donbavand," [let. 130] that his remark concerning flounders being "concealed by *a covering of sand*" is entirely beside the question ventilated in my paper on colour in animals. If your correspondent has ever *seen* a sole or flounder, he must know how accurately the sandy hue is mimicked by the upper side of the animals.—If he had (as I doubt) ever seen a flounder lying motionless and uncovered in an aquarium tank, he would never have penned his sweeping statement above referred to. Permit me to say that I have repeatedly had the greatest possible difficulty, both in gazing into shallow water, and in aquaria, in distinguishing the outline of flounders of whose presence I was aware, from the sand on which they reposed. "B. Donbavand's" remarks on the "extreme tenuity" of scientific investigation (he might have used a plainer term than "tenuity") strike at the root of all scientific advance. Who, pray, is to decide what is important and what is insignificant in scientific research? Who can tell the bearing of even apparently the most trifling fact on future research? "B. Donbavand" arrogates to himself just a little too much authority, when he writes cynically of "extreme tenuity" in such a case as Mr. Darwin's observations on "Worms." The single sentence in "B. D.'s" letter, wherein he speaks of Darwin's work as a "huge paradox," is just a trifle too near silliness to warrant further remark.

In answer to "Ornithorhynchus" [100], who asks why the stings of bees and wasps do not affect a toad when it swallows the insects. I may simply refer him to the common-sense explanation of very plain differences between the constitution of a low vertebrate, such as a toad or frog, compared with the higher warmblooded vertebrates. Your correspondent is evidently thinking of the effects of the insects' sting on the human type when he puts his question concerning the immunity of the toad. But analogy reveals many examples of the fact that the powers of different quadrupeds to resist the evil effects of noxious foods, must be due to differences in the nervous sensibility, and to other features in the constitution of the animals in question. A donkey eats raw nettles, a dietary that would kill a man by producing severe throat inflammation. A secretary bird devours serpents, which may contain poisonous matter sufficient to kill a legion of birds; and man is in the same position as the bird, inasmuch as he can *swallow* safely poisons which only act when introduced directly into the blood-circulation. In a word, individual or race peculiarities serve to render innocuous to one animal what is a poison to another. The black races of men do not suffer from yellow fever, which kills off the white. A tropical sun burns and blisters a white skin, but leaves the black skin untouched.

The second Query [101] of "Ornithorhynchus," regarding "ants," will be best answered by referring him to Sir John Lubbock's "Scientific Lectures" for a full exposition of what is known about the habits of those insects.

ANDREW WILSON.

SCIENTIFIC GHOSTS.

THE following paragraphs are from the "Leaves from a Naturalist's Note Book,"* by our esteemed contributor, Professor Andrew Wilson, a work we can cordially recommend. It contains articles (some of which many of our readers may have seen in various magazines and journals) on many and very various subjects, Giants, Kangaroos, Food and Fasting, Jelly Fishes, Whales, Science and Crime, Leaves, &c., &c., all treated clearly and correctly, and all treated in a most attractive manner. The subject we select for extract is a good illustration of Professor Wilson's method:—

Modern science has made us aware that the old belief in apparitions rested on nothing more than illusive fancies caused by some kind of physical derangement of the person so affected. It is important that young persons should be made thoroughly aware of the fact that there never was and never will be any such fancy which is not capable of being explained upon natural grounds. A person in weak health, though in perfect possession of all his faculties, begins to be troubled by waking visions of persons with whom he may be familiar, or who may have been long dead, or who sometimes may appear as perfect strangers to him. The spectres who flit before him, "come like shadows" and "so depart." They represent, in the most perfect manner, the reproductions of things that are or were—utterly intangible creations. The subject of these visitations may hear the spectres converse, and they may even talk in turn to him. He is perfectly aware of their visionary nature, and is as convinced of their unreality as is the friend who sees them not, and to whom the phantoms are described. No suspicions of insane delusion as to these visitations can be entertained for a moment, and the question may therefore naturally be put to the man of science, "How can these illusions be accounted for?" The answer is to be found in one of the simplest studies in the physiology of nerves and of mind, and shows us that these illusions have a material basis, or that, in the words of the poet, the

"Shadow proves the substance true."

One of the most interesting cases of vision seeing by a person of culture and intelligence is that related in the *Athenæum* of January 10, 1880, by the Rev. Dr. Jessopp, who, in Lord Orford's library, when engaged in copying some literary notes, saw a large white hand, and then, as he tells us, perceived "the figure of a somewhat large man, with his back to the fire, bending slightly over the table, and apparently examining the pile of books I had been at work upon." The figure was dressed in some antique ecclesiastical garb. The figure vanished when Dr. Jessopp made a movement with his arm, but reappeared, and again vanished when the reverend narrator threw down a book with which he had been engaged. Dr. Jessopp's recital called forth considerable comment, and amongst others a letter from the present writer, detailing the familiar theory based on the principles of subjective sensations, treated of in the present paper. After noticing the fashion in which subjective sensations become projected forwards, the author says (*Athenæum*, January 17, 1880): "The only point concerning which any dubiety exists, concerns the exact *origin* of the specific images which appear as the result of subjective sensory action. My own idea is that almost invariably the projected image is that of a person we have seen and read about. . . . In Dr. Jessopp's case there is one fact which seems to weigh materially in favour of the idea that the vision which appeared to him in Lord Orford's library was an unconscious reproduction of some mental image or figure about which the Doctor may very likely have concerned himself in the way of antiquarian study." It is most interesting to observe that in the succeeding number of the *Athenæum*, Mr. Walter Rye writes: "Dr. A. Wilson's solution 'that the "spectre" . . . was an unconscious reproduction of some mental image or figure about which Dr. Jessopp may very likely have concerned himself in the way of antiquarian study,' seems the right one, and I think I can identify the 'ghost' The ecclesiastically dressed large man, with closely cut reddish-brown hair, and shaved cheek, appears to me the Doctor's remembrance of the portrait of Parsons, the Jesuit Father, whom he calls in his 'One Generation of a Norfolk House,' 'the manager and moving spirit' of the Jesuit mission in England. . . . Dr. Jessopp when he thought he saw the figure, was alone in an old library, belonging to a Walpole, and Father Parsons was the leader of Henry Walpole, the hero of his just-cited book. Small wonder, therefore, if the association of ideas made him think of Parsons."

All such illusive visions are thus readily explained as the creatures of an imagination which, through some brain-disturbance, is enabled to project its visions forward, on the seats of sense, as the "ringing" in our ears is produced by some irritation of hearing-centre of the brain. The known vision is a reproduction of a present memory, and the unknown vision is the reproduction of a forgotten figure which has nevertheless been stored away in some nook or cranny of the memory chamber.

We may thus dispel the illusion by its free explanation; and science has no higher function or nobler use than when, by its aid, a subject like the present is rescued from the domain of the mysterious, and brought within the sphere of ordinary knowledge.

* "Leaves from a Naturalist's Note Book." By Andrew Wilson, F.R S.E., &c. (Chatto & Windus, London.) Price 2s. 6d.

A VERY IMPORTANT GIFT has been made to the New York Museum of Art by its President, John Taylor Johnston. It consists of a collection of 331 engraved gems made by the Rev. C. W. King, of Cambridge, England, a connoisseur and authority on glyptic art. For the most part these antique gems follow in chronological order the Di Cesnola collection, which Mr. King, in a treatise, called "a true revelation in the history of glyptic art." Speaking of this addition to the museum, General di Cesnola said that with it two more departments were now unsurpassed by any similar ones in the great European Museums. Each of the pieces is accompanied by a plaster cast. The catalogue is in Mr. King's handwriting, and a treatise on glyptic art, by Mr. King, accompanies the collection.—*Frank Leslie's Magazine.*

XUM

Letters to the Editor.

[The Editor does not hold himself responsible for the opinions of his correspondents. He cannot undertake to return manuscripts or to correspond with their writers. All communications should be as short as possible, consistently with full and clear statements of the writer's meaning.]

All Editorial communications should be addressed to the Editor of KNOWLEDGE; *all Business communications to the Publishers, at the Office, 74, Great Queen-street, W.C.*

All Remittances, Cheques, and Post-Office Orders should be made payable to Messrs. Wyman & Sons.

**** All letters to the Editor will be Numbered. For convenience of reference, correspondents, when referring to any letter, will oblige by mentioning its number and the page on which it appears.*

All Letters or Queries to the Editor which require attention in the current issue of KNOWLEDGE, *should reach the Publishing Office not later than the Saturday preceding the day of publication.*

"In knowledge, that man only is to be contemned and despised who is not in a state of transition. . . . Nor is there anything more adverse to accuracy than fixity of opinion."—*Faraday.*

"There is no harm in making a mistake, but great harm in making none. Show me a man who makes no mistakes, and I will show you a man who has done nothing."—*Liebig.*

Our Correspondence Columns.

THE PRIMARY COLOURS.—RED AT THE BLUE END OF THE SPECTRUM.

[149]—I venture to suggest the following explanation of the difficulty raised by M. W. Laing, letter 71, p. 96. The sensitive ends of the optic nerve take the form of cones; each cone is divided into three parts, and each part is able to vibrate independently of the others. As a violin string of a certain length, thickness, density, and tension is only able to vibrate a certain number of times in a second, and is set vibrating by those vibrations of air only which synchronise or keep time with the string's periods of vibration, vibration for vibration, or every second, third, fourth, &c., air vibration to each string vibration, so each part of the cone is set vibrating by those vibrations of ether which synchronise with its periods of vibrations, and by those only. The sensation of red colour is produced by the vibrating of the thick end of the cone, green, not yellow, by the middle, and blue by the thin end, these three being the primary colours; about 392 billions of ether vibrations in a second synchronise, vibration for vibration, with the periods of vibration of the thick end of the cone, and about 757 billions with the thin end of the cone. Now, it is evident that with 784 (twice 392) billions of ether vibrations in a second, every *alternate* ether vibration would synchronise with *each* vibration of the thick end of the cone, and the result would be a weak red, contiguous to and beyond the blue of the spectrum. Thus we should have *about*

392 billions of ether vibrations in a second, represented by					red.
575	,,	,,	,,	,,	green.
757	,,	,,	,,	,,	blue.
784	,,	,,	,,	,,	red.

Higher numbers of vibrations are probably absorbed or reflected by the refracting media of the eye (*i.e.*, the conjunctiva, cornea, aqueous humour, crystalline lens, and vitreous humour).

In giving yellow as a primary colour, the "commissioners" were probably guided by their knowledge of pigments and their compounds, which knowledge only misleads in the matter of coloured lights.

I trust that my explanation, be it right or wrong, is "plainly worded," and the assumed facts "exactly described"; but I cannot hope to rival "M. W. L." in these matters.

W. Rayment, Amateur of Sc.

THE MOON'S ROTATION.

[150]—C. O. K.—[39]—Newcomb, in his "Popular Astronomy," says:—"The most remarkable feature of the motion of the moon is that she makes one revolution on her axis in the same time that she revolves round the earth. . . . The reason of this peculiarity is to be found in the ellipticity of her globe. That she should originally have been set in revolution on her axis with precisely the same velocity with which she revolved around the earth, so that not the slightest variation in the relation of the two motions should ever occur in the course of ages, is highly improbable. . . . The effect of the attraction of the earth upon the slightly elongated lunar globe is such that if the two motions are in the beginning very near together, not only will the axial rotation accommodate itself to the orbital revolution around the earth, but, as the latter varies, the former will vary with it, and thus the correspondence will be kept up."

Herschel, "Outlines of Astronomy" (S. 436[a]), refers to a remark made by Professor Hansen, viz., "that the fact of the moon turning always the same face towards the earth is in all probability the result of an elongation of its figure in the direction of a line joining the centres of both the bodies acting conjointly with a non-coincidence of its centre of gravity with its centre of symmetry." He then gives a practical illustration.

"Suppose, then, its (the moon's) globe made up of materials not homogeneous, and so disposed in its interior that some considerable preponderance of weight should exist excentrically situated, then it will be easily apprehended that the portion of its surface nearer to that heavier portion of its solid content under all the circumstances of a rotation so adjusted will permanently occupy the situation most remote from earth."—A. T. C.

FOUR FOURS, SINGULAR NUMERICAL RELATION.

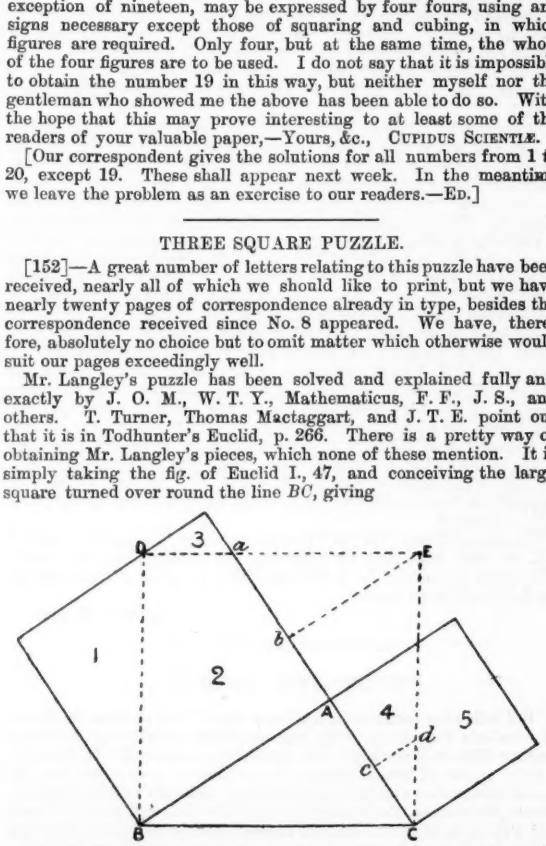
[151]—It may be as new to some of the readers of KNOWLEDGE as it was to myself when first shown the other day that all the numbers to twenty inclusive (and many upwards), with the single exception of nineteen, may be expressed by four fours, using any signs necessary except those of squaring and cubing, in which figures are required. Only four, but at the same time, the whole of the four figures are to be used. I do not say that it is impossible to obtain the number 19 in this way, but neither myself nor the gentleman who showed me the above has been able to do so. With the hope that this may prove interesting to at least some of the readers of your valuable paper,—Yours, &c., CUPIDUS SCIENTIÆ.

[Our correspondent gives the solutions for all numbers from 1 to 20, except 19. These shall appear next week. In the meantime we leave the problem as an exercise to our readers.—ED.]

THREE SQUARE PUZZLE.

[152]—A great number of letters relating to this puzzle have been received, nearly all of which we should like to print, but we have nearly twenty pages of correspondence already in type, besides the correspondence received since No. 8 appeared. We have, therefore, absolutely no choice but to omit matter which otherwise would suit our pages exceedingly well.

Mr. Langley's puzzle has been solved and explained fully and exactly by J. O. M., W. T. Y., Mathematicus, F. F., J. S., and others. T. Turner, Thomas Mactaggart, and J. T. E. point out that it is in Todhunter's Euclid, p. 266. There is a pretty way of obtaining Mr. Langley's pieces, which none of these mention. It is simply taking the fig. of Euclid I., 47, and conceiving the large square turned over round the line *BC*, giving



We thus have the five pieces of Mr. Langley's figure, and, at the same time, see how they are to be arranged to fill the square *BE*. We leave 2 where it is; put 1 where *BAC* is, 4 on *Eab*, and then 5 and 3 together cover the triangle *bEc*, divided as shown by the line *cd*.

R. A. Proctor.

THE QUERIES IN "KNOWLEDGE" (*Abstract*).

[153]—Perhaps you will forgive my making a few observations on KNOWLEDGE. Like many, doubtless, I have profited very much by such essays as those in the first half of each number. But, Sir,

t is very hard that space should be taken up with questions, the answers to which are in well-known text-books. May I suggest that such questions be not inserted, but answered shortly in the small print "Answers to Correspondents."

I also thought it very hard that so much room was given for "that the sun is cold," to men whom you say cannot comprehend an argument derived from the solar dark lines.—Yours, &c.,

ANTI-PARADOX.

[Anti-Paradox's letter is allowed to appear as a rather remarkable specimen of the class to which it belongs. Among some twenty or thirty kindly letter, recognising what we are trying to do in KNOWLEDGE, and, indeed, giving us credit for a degree of success which we ourselves would hardly claim, will come a letter or two such as the above. Anti-Paradox's complaint reminds us of a remark of a theatrical agent we met in New York, who said there were some who would not go to the theatre "unless they had orders given for all their family, and *then* they complained unless first-class carriages were sent to take them along." Putting aside the question whether those who have queries to ask have not a right to expect some space, and noting that many primers and text-books are not simply worded, even when (which is not always the case) they are exactly described, we would invite "Anti-Paradox," and the small proportion of our readers who view matters like him, to consider things from the point of view of the proprietors of such a journal as this. "Anti-Paradox" pays twopence for each copy, of which sum more nearly the half than three-fourths reaches the proprietors of KNOWLEDGE. Let "Paradox" inquire how much twelve, fourteen, or sixteen double leaves (as the case may be) of good paper is likely to cost, even at wholesale rate, and the probable expense per copy of such matters as composing, printing, folding, advertising, and so forth, to say nothing of editing. When he has done this, and notes the nature of the margin between a penny-farthing and such costs per copy, let him ask himself if it is quite reasonable for him to expect us to crowd queries, correspondence, &c., into "the small print 'Answers to Correspondents,' in order that he may have as nearly as possible the entire contents of KNOWLEDGE devoted to original matter. Observing that a page of small print in itself involves a loss (costing more than twice as much as a page of large print), let him notice that, on the average, we give him, as it is, as much original matter as would make the sixth part of such a work as my "Light Science" or Professor Wilson's "Leisure Hour Studies"—so that, for a shilling, he gets as much of such matter (fresh and fresh) as in such volumes costs six or seven shillings. It is "a very hard thing," he considers, "that we do not fill our entire space with matter so costly that if we did, the greater the sale, the greater would be the proprietors' loss. It would be, we venture to tell him, a "very hard thing" if our reward for giving six or seven pages of extra space to correspondence should be a claim for so much more original matter. It is "a very hard thing" to find room for so much original matter as we insert, and also to give space for correspondence, queries, &c., without making the proprietors cry out lustily at our extravagance (considering the price of KNOWLEDGE). If we had many such cheerful correspondents as "Anti-Paradox," this "very hard thing" would simply become impossible. We beg, on the proprietors behalf, to remind "Anti-Paradox" that the "very hard thing" which affects him is an infliction of his own choosing. He is not obliged to bring this terrible hardship on himself by expending the sum of twopence weekly on KNOWLEDGE, and then groaning because we answer queries in other than our smallest type, or admit inquiries from readers who do not fully appreciate the significance of the solar dark lines. To our more just and generous readers we say that we do the best we can to oblige all; we give to each class, correspondents, querists, mathematical students, chess and whist players, and original writers, more space than we can fairly afford. We feel satisfied that so long as we do so, the proportion disposed to be as unreasonable as "Anti-Paradox" and a few others have hown themselves, will be very small indeed.—THE EDITOR.]

THE FIFTEEN PUZZLE.

[154]—The following is a solution to the Fifteen Puzzle, starting from the lest position :—

1	2	3	4
5	6	7	8
9	10	11	12
13	15	14	

Let R = right L = left U = up and D = down.

12. D.—11.10.9. R.—13. U.—15.14.12. L.—11. D.—10.9.13. R.—15. U.—14.L.—13.D.—9, &c., to L until the figures of the last two rows read.

9	10	11	12
15	14	13	

Then move: 15.14.13. R.—9.5.1. D.—2.3.4. L.—8.12.13. U.—14.15.9. R.—5.1.2. D.—3.4.8. L.—12.13.14. U.—15.9.5. R.—1.2.3 D.—4.8.12 L.

Then turn the box so that

4	8	12	
3	6	7	13
2	10	11	14
1	5	9	15

will be

1	2	3	4
5	10	6	8
9	11	7	12
15	14	13	

Then move: 14.13. R.—11.10. D.—6. L.—7. U.—14. U.—15.11 R.—9. D.—10.14. L.—11. U.—15. R.—14. D.—11.12. L.—13. U.—15.14.9. R.—10. D.—11.12.13. L.—15. U.—14. R.—13.D.—12.11. R.—10. U.—9.13.14. L.—15. D.—12.11.10. R.—9. up.—13.14.15. L.

Wishing success to your valuable paper,—I remain, yours truly,

YAWNUPS.

[The position attained by "Yawnups," which, of course, he does not regard as an actual solution of the problem, for which a money prize was offered in America, can be more readily reached; in fact, we do not see the plan of "Yawnups'" solution, many of the moves in which seem to be wasted. The actual number of moves in his solution, counting such a move as 9.13.14. L as three moves, is 102. By the following method the position is attained in 57 moves. It may, perhaps, be done in fewer, but the solution is straightforward, and its stages illustrate the method of dealing with such difficulties as occur in all "fifteen" problems:—4.8.12. D.—12.3. R.—13.9.5. U.—15.14.12. L.—3.4.8. D.—5.1.2. R.—15.13.9. U.—14.12.8. L.—2.3.4. D.—1. R. Now turn the box so that right hand runs

1	2	3	4

after 28 moves. We next get 5, 6, 7 right by the following moves:—7.11. L.—10. U.—6. L.—11. D.—7. R.—5. U.—6.11. L.—10. D.—7. R.—6. U. The two upper rows are now right, after 12 moves more, or 40 moves in all thus far. The last two lines now run thus :—

11		10	12
9	13	15	14

To get these right proceed thus :—11. R.—9. U.—13.15. L.—10. D. 11. R.—15. U.—10.14. L.—12. D.—11. L.—15. R.—10. D.—14. L.—15. D.—11. L.12.— U. The last two rows are now right, after 17

1	2	3	4
5	6	7	8
9	10	11	12
13	14	15	

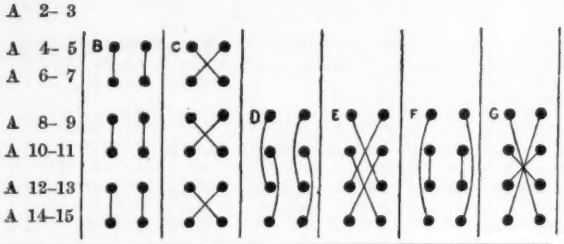
more moves, or 57 moves in all. The blocks are now in the order which we may regard as one of the only possible forms of solution from the "lost position."—ED.]

We have since received the following solution in 60 moves.—13.15.14. R.—1.5.9. D—2.3.4. L.—8.12.14. U.—9.13.15. R.—2.1.5 D.—3.4.8. L.—12.14.15. U.—5.9.13. R.—3.2.1. D.—4.8.12. R. One line is now right in 33 moves. Then: 14.15. U.—10.11 R.—6. D.—7. L. Two lines are now right in 39 moves. 15. R.—11. U.—13. U.—9. R.—10. D.—15. D.—11. L.—14. D.—12. R.—11. U.—15. U.—13. L.—14. D.—15. R.—11. D.—12. L.—15.14. U.—13. R.—10. U.—9. L.—or all the numbers right in 60 moves. O. F. W.

THE FIFTEEN SCHOOLGIRLS.

[155]—In default of better, I enclose a sort of analysis and rule for doing the puzzle of fifteen, which is the simplest I have been able to find.—Yours, &c. R. N.

The black dots stand for the numbers in the same line with them in the A column.



Otherwise—

A	b	c																
A	d	e	B	d	f	C	d	g										
A	F	g	B	e	g	C	e	f										
A	H	i	B	H	J	C	H	K	D	h	l	E	h	m	F	h	n	G	h	o
A	J	K	B	i	K	C	i	J	D	i	m	E	i	L	F	i	o	G	i	n
A	L	m	B	L	n	C	L	o	D	J	n	E	J	o	F	J	L	G	J	m
A	n	o	B	m	o	C	m	n	D	K	o	E	K	n	F	K	m	G	K	L

The order of walking is then—

A B C	A D E	A F G	A H I	A J K	A L M	A N O
D I M	B L N	B M O	B E G	B D F	B H J	B I K
E J O	C H K	C I J	C L O	C M N	C E F	C D G
F H N	F I O	D H L	D J N	G H O	G I N	E H M
G K L	G J M	E K N	F K N	E I L	D K O	F J L

If the black dot formula is committed to memory, the puzzle can always be done nearly off-hand but, if not, a sure way of getting to the same result is to set down the 105 combinations of two letters from which the 35 combinations of three letters have to be formed side by side, and then amalgamate with *perfect regularity* from the top, cancelling all the used pairs.

A FOOD QUESTION.

[156]—If you think the following extracts have enough of general interest for your "Correspondence" columns, their insertion might lead to our getting some further useful information on the matter:—

In a recent number of *Chambers's Journal* (Nov. 12), under the head "Some Queer Dishes," it is said:—"In the West Indies, where meat becomes tainted very rapidly by the agencies of the damp motionless heat and abundance of insect life, it becomes necessary to cook it almost as soon as it is killed. To obviate the toughness which would result from this, it is wrapped in a large fleshy leaf, which has the curious property of softening the muscular fibre and rendering it tender. If left on too long, the juice permeates the meat and disintegrates it altogether, hastening its decay. I do not know the proper name of this leaf—the black people call it "sangulo"—nor the nature of its action; there is a large tree in the market-place, near the King's Wharf, at St. Thomas."

This is probably the same plant or tree that is mentioned by Mr. H. Stonehewer Cooper, in his "Coral Lands," Vol. I., page 75. He says:—

"The one drawback to Fijian beef is that it is sometimes very tough, in consequence of being cooked the very day it is killed. The papau (*Cerica papaya*) grows luxuriantly all over the Pacific, and according to Mr. Wittwach, a German naturalist, papau is the remedy. The juice of this is found to possess the property of rendering tough meat tender when boiled with it. If the unripe fruit be placed in the water in which the toughest meat is to be cooked, it is found to render it perfectly digestible, and the same results are observed if the meat be merely washed with the juice of the fruit. The thick, white, milky juice, when extracted from the unripe papau, in fact, contains properties similar to those of pepsine; and it is possible that it may be susceptible of chemical preservation, and become a valuable preparation. Tough meat is not unknown in England, and surely papau could be canned and sent over here, even if no mode of preservation is arrived at."

If this leaf or fruit has the virtues attributed to it, it is strange that we have not had it here in some form. "Coral Lands" was published last year.—Yours faithfully, F. C. M.

Nov. 28, 1881.

MAGIC SQUARES.

[157]—I am glad to see that your correspondent "H. S." has started the subject of magic squares in the last number of Knowledge; but though he gives examples of odd squares, he does not give the rules for making them. The subject is of great interest, and some squares are so very curious that I should like, if you will allow me, to bring it more fully before your readers.

Of magic squares there are two kinds; 1, those whose root is an odd number; 2, those whose root is an even number; the rules for the construction of each kind differing from each other.

The examples of odd squares given by "H. S." are made by Bachet's, or the Indian method; and the result is not capable of variation; but by the methods of M. Poignard and others, the resulting squares may be varied in many ways. I will now describe these methods for odd squares, and in a future paper will give the rules for squares with even roots and squares with borders, &c.

Bachet's Method.

Example: A square of 49 cells whose root is 7.

Fig. 1.

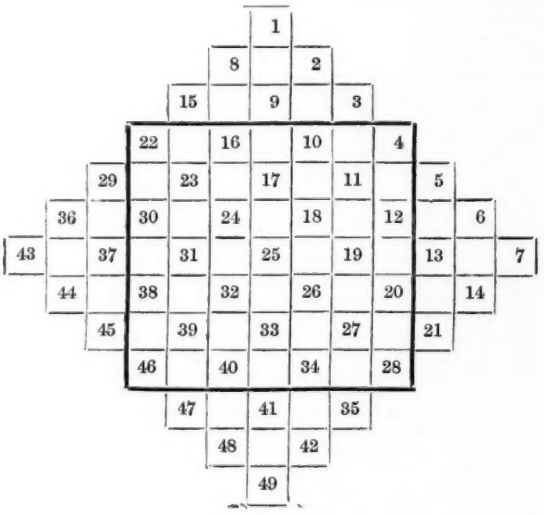


Fig. 2.

22	47	16	41	10	35	4
5	23	48	17	42	11	29
30	6	24	49	18	36	12
13	31	7	25	43	19	37
38	14	32	1	26	44	20
21	39	8	33	2	27	45
46	15	40	9	34	3	28

After having filled in Fig. 1 with the series, as shown above, proceed to transfer the figures in the cells outside the square into the

Pond's Extract is a certain cure for Rheumatism and Gout.
Pond's Extract is a certain cure for Hæmorrhoids.
Pond's Extract is a certain cure for Neuralgic pains.
Pond's Extract will heal Burns and Wounds.
Pond's Extract will cure Sprains and Bruises.
Sold by all Chemists. Get the genuine. [Advt.

empty cells in the square directly opposite to them, as seen in Fig. 2—which will then be a magic square, whose root is 7—and the sum of the numbers in each vertical and horizontal band, and also of those on the two diagonals is 175.

POIGNARD'S METHOD.

For a square whose root is 7.

Fig. 1.

3	7	5	1	6	4	2
5	1	6	4	2	3	7
6	4	2	3	7	5	1
2	3	7	5	1	6	4
7	5	1	6	4	2	3
1	6	4	2	3	7	5
4	2	3	7	5	1	6

In the square, Fig. 1, place in the top horizontal row the first seven numbers of the progression 1 to 7 in any order whatever, as 3, 7, 5, 1, 6, 4, 2. Then choose a number which is prime to the root 7, and which, when diminished by unity, does not measure it, say 3. Begin the second row with the third figure of the first. The third row with the third figure of the second, &c., and fill up the square.

Fig. 2.

28	7	42	0	14	35	21
0	14	35	21	28	7	42
21	28	7	42	0	14	35
42	0	14	35	21	28	7
35	21	28	7	42	0	14
7	42	0	14	35	21	28
14	35	21	28	7	42	0

In the top row of Fig. 2, place the multiples of the root 7, beginning with a cipher, viz., 0, 7, 14, 21, 28, 35, 42, in any order at pleasure; and fill up the square on the same principle as in Fig. 1, taking care not to assume the same number for varying the order of the figures. As 3 was taken for Fig. 1, we may take 4, or 5, or 6, for Fig. 2, say 4. Then the square will be filled up as in the margin. Now add the corresponding numbers in each cell of Figs. 1 and 2, and place the sum in Fig. 3, which will be a magic square.

Fig. 3.

31	14	47	1	20	39	23
5	15	41	25	30	10	49
27	32	9	45	7	19	36
44	3	21	40	22	34	11
42	26	29	13	46	2	17
8	48	4	16	38	28	33
18	37	24	35	12	43	6

It is easily seen that by this method the position of the numbers in the finished square may be varied greatly, and I leave it to the readers of KNOWLEDGE to say how many ways there are of varying the square of 7.

J. A. MILES.

INTELLIGENCE IN ANIMALS.

[158].—Referring to Mr. Henslow (p. 46, No. 3), is not his reasoning somewhat curious? He tells us that had the dog not been taught to ring the bell, his reasoning would have been abstract. As the fox was *not* taught to do what he did, why was not his reasoning abstract?

Another story is still more *apropos*. In this case the fox cut the line connecting the trigger with the bait, then went up deliberately (as seen by his track on the snow) and ate the latter. In this case the fox could not scrape a trench, so as to get safely at the bait, as there were only a few inches of snow on the ice where the bait lay.

In neither of these cases had the foxes been taught to do what they did, yet each in his own way used reasoning powers which enabled him to accomplish his object in the only way by which it could be safely attained by an individual fox (or man), ignorant of the mechanism of firearms. Was this abstract reasoning?

Mr. Henslow is rather hard upon brutes and boys. Every day we find what are supposed to be educated, reasonable, and, I presume, reasoning men and women, doing as silly things as the most stupid "boy or brute" could be guilty of."

Ask twenty persons what they would do if, whilst exposed to great cold, they found their faces freezing? Probably, nineteen of the twenty would reply, "rub with snow." This would be proper treatment if a person frozen was brought into a warm house, but is not right whilst he is exposed to the low temperature that is freezing him.

This snow application was improved upon by Major Burnaby' when, on his ride to Khiva, he thought his hands were freezing. He added brandy to the snow before rubbing it in, and thus made a sort of freezing mixture, as anyone can easily prove by trying it on some cold day, and exposing the part rubbed to the air. The brave lady who ascended Mont Blanc in winter adopted the same plan, and thought it successful.

J. RAE.

[In a paragraph, which we have omitted, Mr. Rae appears to have misunderstood Mr. Henslow's remark about "pulling the string out of the line of fire." Mr. Henslow meant the fox being out of the line of fire while pulling, not the fox pulling the string away from the line of fire.—ED.]

[159]—In favour of the lower animals possessing reasoning powers, I submit the following:—

While living in Dublin, a few years ago, we had two female cats—one a "tabby," the other a "tortoiseshell." The tabby, my especial pet, was of rather fierce disposition, but an excellent mouser, and was in the habit of bringing her prey, generally alive, to show me before devouring it. The tortoiseshell—a feline beauty—passed the greater part of the day on the rug before the fire. One day, "Tabby" brought no less than three mice, consecutively, into our sitting-room. The first two she ate; but the third, after playing with it for some time, she hid under a mat at the door, evidently meaning to reserve it till a hungrier moment. As soon as she left the room, the tortoiseshell, who had been sitting, as was her wont, with half-closed eyes before the fire, went to the mat, poked out the mouse, and gobbled it. This theft amused me so much that I resolved to watch the consequences. Tabby did not come in again till evening, when she proceeded instantly to fetch out her mouse. She searched well under the mat, but not finding her *bonne bouche*, began growling ominously. At length her eyes fell upon the guilty tortoiseshell, upon whom she rushed, and beat and scratched her until in pity we rescued the culprit. Another time both cats were with kitten. The tortoiseshell disappeared for a few days, and returned looking very lean and miserable. Tabby, who had meanwhile brought forth her young, received her more amicably than usual, and after some rubbing of noses and purring, the tortoiseshell took charge of the kittens, and suckled them. This was not the only time she was seen doing duty as wet-nurse, whilst the other was rambling somewhere round.

A. F. R.

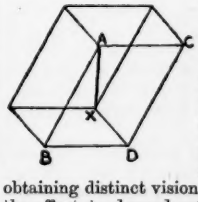
A BEAR'S MEMORY OF LANGUAGE.

[160]—The strategic shifts of Colonel Perkins' (Purtons' ?) dog, Bully, at Bangalore, reminds me of another story connected with Bangalore. The late Rev. William Campbell, who was formerly a missionary there, on visiting Dublin, to advocate the claims of the London Missionary Society, went with some friends to see the Zoological Gardens in that city. While walking through the gardens, their attention was drawn to a particular den by the excitement of a small crowd before it. On approaching the place, they found it was the den of the Indian bear. Bruin was in a bad humour, and sat resolutely on his haunches, with his back to his visitors. Some tried to coax him with buns, others to startle him with shouts, and a few tried to stir him up with walking-sticks and umbrellas. All their efforts were in vain. At last it occurred to Mr. Campbell to address the bear in the language he was accustomed to in his youth, so he shouted "Cuddapah! Cuddapah!" (Get up! Get up!) To the surprise and amusement of the spectators, Bruin immediately turned round with a delighted grin.—Yours, &c.

CUDDAPAH.

AN ILLUSION.—DURATION OF FLASH OF LIGHTNING.—RAINBOW.

[161]—Wheatstone calls attention to the following illusion first mentioned by Professor Necker, of Geneva. The rhomboid AX is drawn so that the solid angle A should be seen the nearest to the spectator, and the solid angle X the farthest from him. But in looking at the rhomboid, it will occasionally so change that the solid angle X will appear the nearest, and the solid angle A the farthest away. Necker attributed the alteration of appearance not to a mental operation, but to an involuntary change in the adjustment of the eye for obtaining distinct vision. Wheatstone, on the other hand, supposed the effect to depend entirely "on our mental contemplation of the figure intended to be represented, or of its converse."



I think Mr. Molloy (letter 116, p. 121) will find no account of any experiments of Wheatstone's on the duration of a flash of lightning in the collected volume of his papers issued by the Physical

Society of London. In the paper to which Mr. Molloy refers, "An Account of some Experiments to Measure the Velocity of Electricity and the Duration of Electric Light," Wheatstone gives an account of experiments made on the duration of the electric spark, as produced in the laboratory, and towards the conclusion of his paper he states that "the light of electricity in a state of high tension has a less duration than the millionth part of a second."

If "G. S. M." (query 67) could see a rainbow under perfect conditions, it would appear not semicircular, but circular. If, for example, he were up in a balloon, at a great height, with the sun overhead, and a rain-shower beneath, he would see a circular rainbow below, probably with the shadow of his car and its occupants fair in the centre. A rainbow being formed by those raindrops which are placed at a particular angle with regard to a line drawn from the sun through the head of the observer, it is apparent that as our balloon descended towards the earth the coloured ring would descend also, until finally it impinged on the earth's surface. Upon going lower still, the continuity of the ring would be broken, the earth having taken the place of some of the raindrops, and, probably by the time the observer had reached the ground, he would be only able to see a semicircular rainbow.

Wm. Ackroyd.

COMETS' TAILS.

[162]—In reply to the query by F. C. S., p. 119, Mr. G. M. Seabrook, Temple Observatory, Rugby, writing to *Nature*, says:—"The comet (b. 1881) was examined spectroscopically here last night. The nucleus gave a bright, continuous spectrum, while the coma and brighter portions of the tail gave the three least refrangible hydrocarbon bands superposed on a faint continuous spectrum. On moving the slit of the spectroscope towards the fainter part of the tail the bands died out, leaving a faint continuous spectrum, which, again, gradually faded away as the end of the tail was approached. I have not measured the position of the bands, but they are sensibly the same as those from an alcohol flame."

Mr. Percy Smith, of the same Observatory, on July 1, writes:—"On the 27th (June), the bright jet extending from the nucleus was very plain, and gave the hydrocarbon spectrum very distinctly. No bands were seen in the tail, but only in the immediate proximity of the nucleus."

M. Wolf, in a paper read to the Paris Academy on July 11 (in regard to the same comet) says: ". . . "When the slit of the spectroscope is passed over the comet, starting from the head, one finds the three bands all round the nucleus at nearly the same distance from all the sides. They disappear in the tail properly so-called, the very pale spectrum of which seems to be continuous. Thus only the nebulosity surrounding the nucleus contains incandescent gases. The light of the tail comes to us from a pulverulent matter luminous or simply illuminated. Such are the data of spectroscopy."

A. T. C.

AN INSTANCE OF PRESSURE.

[163]—The readers of Knowledge have, doubtless, been interested in the scientific controversy on the subject of toads being enabled to live, enclosed by blocks of solid matter; probably the following fact will be unknown to many of them, and may afford additional proof of the frog's vital tenacity:—

A few years ago an experiment was made in the Arsenal at Woolwich, the particulars of which were published by the well-known Mr. Tegetmeier, of the *Field*. A frog was subjected to the enormous pressure of three tons to the square inch, for a period of thirty-six hours. At the end of the experiment the frog appeared prostrate, but recovered a perfectly normal condition in a few hours, and as a reward for his severe test, was taken back to his native marshes.

R. C. Fraser.

A geography of the almost unknown kingdom of Corea has been compiled by a member of the suite of the Japanese envoy to that country. Several valuable papers, containing accounts of travels in Corea, have been read before the Geographical Society of Tokio, and have appeared in its transactions. As they are written in Japanese, they are unfortunately all but inaccessible to European geographers. —*Frank Leslie's Magazine.*

The French Minister of Commerce has just issued a notice regarding the inspection of salted pork imported from abroad. Inspectors are to be appointed at the different ports to which the entry of this commodity will be confined. A course of lectures on the subject of micrography is to be instituted at the School of Pharmacy for the preparation of the experts who will be required for these posts. These measures foreshadow the eventual raising of the embargo on American pork.

Queries.

[130]—Known Languages.—I shall be glad if you, or any of the readers of Knowledge, can tell me the number of known languages spoken at the present day.—J. A. L. R.

[131]—Creation.—Will any correspondent versed in this subject give his views as to what are the proofs of man having existed more than six thousand years?—R. I. P. [R. I. P. should read, amongst other works, "Quatrefages on Man," in the International Series, published by Kegan Paul & Co., London. Price 5s.—Ed.]

[132]—Fungi.—I shall be glad to have any information respecting the nature of fungi and truffles; how they are produced, and what their place is in the vegetable kingdom.—Ignotus.

[133]—Would you kindly inform me if you know of any works, articles in magazines, or anything whatever by the Rev. W. H. Dollinger, F.R.S.?—Querist.

[134]—The Stars in Northern and Southern Latitudes.—Would you oblige a boy by explaining the reason why we in northern latitudes do not see the whole of the southern constellations, as people in southern latitudes see all our northern constellations? Vide page 12 of "Easy Star Lessons." You state the fact, but do not give the reason.—Quisquis.—[At the North Pole, the pole would be overhead, and the heavens turning around on upright or vertical axis, we should see only one half the star sphere, even if we watched through twenty-four hours of an arctic winter's day (really night). At the equator, the poles being on the horizon, we should see the whole star sphere, turning as it does round a horizontal axis, in the twelve hours of an equatorial night. In intermediate positions, more or less of the star-sphere would be seen the nearer the station to the equator. You must not confound latitudes south of ours with southern latitudes.—Ed.]

[135]—Cheap Telescope.—I am wishful to have a *cheap* telescope, such as would answer a beginner; say a 2½" or 3" object-lens. Would any reader give me a few hints as to construction, what would be probable cost, including tube, &c.?—R. I. P.

[136]—Sunlight on Fires.—Does bright sunlight interfere with ordinary combustion? If, as I believe, it does, I should be glad to have a scientific explanation of the fact. As evidence, let me quote the housemaid, who says she cannot get her fire to burn if the sun is shining upon it. And the smoker, who says that he cannot keep his cigar alight under the same circumstances.—N.

[137]—Humble Bees.—What success has attended the attempt to introduce humble bees (*Bombus terrestris*) into New Zealand, to fertilise the clover there? The first attempt was unsuccessful, but I have been unable to learn the fate of the second attempt.—Thomas Chandler.

[138]—The Gyroscope.—What particular laws of motion are illustrated by the gyroscope? Does it throw any light upon planetary motions? And what? Of what motions is the instrument capable, and can they be popularly explained? Is there any simple treatise on the subject? Can you give some easy papers upon it in Knowledge?—T. W. F. [Newton considered the movements of a rotating body under gravity among the most difficult problems which mathematics can deal with. We have tried elsewhere to make this difficult matter clear, and may try again soon in these pages. —Ed.]

[139]—Temperature of Interstellar Space.—What is the supposed temperature of interstellar space, and how has it been ascertained?—E. C. R.

[140]—Ice.—Does the volume of ice vary as other solids do with variation of temperature?—E. C. R.

[141]—Time of Glacial Epoch.—Is Dr. Croll's theory of the time at which the ice age existed in Britain probably correct? Are there other theories on the same subject?—E. C. R.

[142]—The Great Bear.—Will some reader of Knowledge inform me if it is possible to see the Great Bear 17½° south of the equator? I read in a book (and the author ought to have known) that it is so, but it seems hardly credible. Would some one state how far south it may be seen?—Marian. [Any star of the Great Bear can be seen just as many degrees south of the equator as that star is distant from the pole of the heavens.—Ed.]

The biggest thing yet in the way of plaster casts is the cast of a whale, taken at Provincetown by Mr. Palmer, modeller for the Smithsonian, at Washington. A papier-mâché fac-simile is to be moulded from the cast, the entire skeleton of the same whale is to be inserted, and the monster will be suspended in the museum. To show the arrangement of the skeleton, one side of the whale will be left open.

XUM

Replies to Queries.

[103]—Histology.—Your correspondent may be glad to know of the following books on "Histology":—"1. Frey's, translated by Barker (expensive); 2. Rutherford's "Outlines of Practical Histology," is very good for students; 3. Klein's "Atlas" is a grand work on this subject, but too expensive.—B. Tom Tiny.

[39]—Moon's Rotation.—I give a quotation from the lecture delivered by Dr. Ball, at the Midland Institute, Birmingham, Oct. 24, 1881:—"For many centuries it had been an enigma to astronomers why the moon should always turn the same face to the earth. It could be shown that there were many million chances to one in favour of this being due to some physical cause. The ordinary theory of gravitation failed to explain the cause. Every one had noticed this phenomenon, yet the explanation was never given till lately. It was Helmholtz who showed that this was a consequence of ancient tides, and this simple and most satisfactory explanation has been universally accepted."—A. T. C.

[88]—Brain Troubles.—The division of the brain into two parts will certainly not take in all the functions of the brain; at least one more must be added. The division into *a*, involuntary motion, *b*, centres of reasoning, higher emotions, &c., cuts out entirely the function of voluntary motion presided over by the brain. Also the function of the cerebellum, that of co-ordination of muscular actions, or muscular sense, is left out, and is certainly important; for a pigeon, having his cerebellum removed, cannot stand, but topples over, and although seeing a blow threatened, cannot avoid it. When lying down, it was not in a state of stupor.—P. H.

Notes on Art and Science.

At Gnosso, in Crete, Professor Stilman has excavated the remains of what he believes to be the historical labyrinth famous from the story of Theseus and the Minotaur.

At Honolulu, a signal station in communication with the United States Meteorological Bureau will be established on the volcano Kilauea, and a series of observations will be taken.

The Sunday Society.—The twenty-sixth Sunday Art Exhibition of the society was opened on Sunday, Dec. 18, at the Hanover Gallery, from half-past one till four o'clock, when there was an attendance of 512, the admission being by ticket.

Dr. Schondorff has constructed a safety lamp which can only be opened with the help of a strong magnet. A lever presses against a toothed wheel, which allows or prevents the movement of the screw fastening the glass door-holder to the socket. The lever must be moved in order to open the lamp, and this is done by means of a strong magnet.

Brugsch Pasha has succeeded in deciphering the Ethiopic inscriptions of Meroe, the language of which resembles that of the Ethiopic *graffiti* on the walls of Philæ and other Nubian temples. He thinks that the language has some similarity to the pre-Semitic Sumerian dialect of Southern Babylonia, and quotes in support of this view words like *sher*, "King."

A most remarkable discovery has been made in the Sweetwater country, in Wyoming territory. It is a deposit of sulphuric acid in its natural state. The odour, chemical action, and general appearance of the stuff demonstrates it to be a pure quality of sulphuric acid. The ground is impregnated over a large area—100 acres or more—and parties have filed claims upon it.

A congress of experts has assembled at St. Petersburg to inquire into the evils caused by excessive drinking in Russia. By an overwhelming majority they have advised a diminution in the number of public-houses; while they also passed a resolution in favour of vesting in the communal authorities the right of opening liquor-shops under regulations to be determined by a sub-committee appointed for this purpose.—*Frank Leslie's Magazine.*

The survey of Palestine east of the Jordan is proceeding rapidly under the superintendence of Lieut. Condor. When he last wrote, several hundreds of miles had been measured with accuracy, and a number of places having more or less modern names were identified as those mentioned under different titles in ancient history. He discovered a great many cromlechs, or flat stones, supported like a table by others set on end. Not less than fifty of these monuments were sketched in three days. Some of them had small chambers near them from 3 ft. to 5 ft. long, and 3 ft. high, excavated in detached cubes of rock 10 ft. to 15 ft. on each side. The interest in the work is increasing, and the result cannot fail to be of great archæological importance.—*Frank Leslie's Magazine.*

A Simple Electrical Machine.—As a domestic electrical experiment, few are simpler or more demonstrative than that of first drying and warming a piece of paper, then smartly stroking it with india-rubber and placing it against a wall, to which it electrically adheres. Electric sparks may thus be obtained in the dark, and a variety of other experiments performed. When the wind is from the east, and dry, a small Leyden jar may be charged by using a long strip of paper, equal in width to the outer coating, and drawing this repeatedly, when excited, along the outside of the jar. An improvement on this simple electrical material has recently been made by Wiedemann. He takes Swedish filtering-paper (procurable wherever chemical apparatus is sold), steeps it in a mixture of equal volumes of nitric and sulphuric acid, then washes with abundance of water, and dries it—the same process as making gun-cotton, into which the fibres of the paper are thus converted. It is stated that with this gun-cotton paper, nearly all the stock experiments of the static electrical machine may be performed by laying a sheet of it on waxed paper for insulation, and rubbing it briskly. This was announced in the *Comptes rendus* of the French Academy about the beginning of the year, but I have heard no more of it since. As Christmas holidays are coming, I recommend it to my juvenile readers, who may possibly be able to improve upon the original suggestion by coating a fig-box, or other wooden cylinder, with a non-conducting surface of gutta-percha varnish, or shellac, or wax, then covering this with the prepared paper, and mounting it like an ordinary old-fashioned electrical machine; or by making an electrophorus of this material.—W. Mattieu Williams, in *Gentleman's Magazine.*

The Bursting of Water-pipes.—In a country like England where the obstinate natives persist in the practice of burning their fuel in a hole made in the wall, with a shaft rising perpendicularly above it, in order that the greatest possible quantity of the heat of combustion shall be devoted to warming the clouds, and the smallest possible amount shall be radiated from only one side of the fire into the apartment, anything like a severe frost becomes a national calamity. Last winter, though far less severe than an average winter in Germany or the United States, is made miserably memorable by the domestic calamities connected with the bursting of water-pipes, and is recorded in the household accounts of expenditure for mending the same and repairing the damage done by the general house-and-furniture-soaking. If English houses were equally warmed *throughout*, as they are in other countries where domestic civilisation has made some progress, the freezing of any water-pipe inside would be impossible in any weather, and all outside water-conveyance can be made underground. But as the domestic fetish of the Englishman and Englishwoman, the hole-in-the-wall "cheerful" fireplace, must be worshipped; as the fire-worshippers must continue to scorch their noses while their backs are matriculating for lumbago; as the cheerfulness of the fetish must be maintained, and its devotees must demonstrate that cheerfulness by staring vacantly at the glowing coals which roast everything and everybody at one side of the room, while the rest of the house is at the mercy of the outside fluctuations of temperature; as all this must go on for a generation or so longer, in spite of Kyrle societies and smoke-abatement exhibitions—some adaptation of water-pipes to our existing domestic barbarism is very desirable. A very little geometry is required for understanding that if a pipe of circular section be flattened in any degree, its internal capacity must be proportionately lessened; and conversely, that a pipe thus flattened, or made of elliptical section, may have its internal capacity enlarged by simply squeezing it out towards the circular shape. Lead being flexible, a leaden pipe made of elliptical section and filled with freezing water will swell out towards circular shape, and thus allow room for the expanded ice without bursting. It is proposed that such pipes be made and used, and I think the idea an excellent one though plumbers are not likely to favour it, but their disapproval should be a strong recommendation to the householder who has to pay for mending ordinary pipes. I am told that a patent has been secured, but do not know by whom, and as I am going to suggest an infringement, he is entitled to any advertisement this note may afford. I recommend all householders to save their existing pipes by simply flattening them with a mallet, taking care to place behind the part which is struck a flat piece of wood, where the pipe rests upon rough brick-work. The freezing will simply reverse the work of the mallet, and lead of good quality will bear this double-bending. If freezing water were a rigid solid, the transverse expansion of the cylinder of ice within the tube would be proportionate to its diameter, and thus the elliptical form would be maintained; but freezing water is not a solid; it exerts an equal expansive pressure in all directions; and the walls of the pipe being equally pressed, give way in the direction of least resistance.—*Ibid.*

XUM

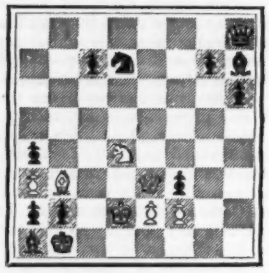
Our Chess Column.

In the *Illustrated London News* for Nov. 5 last, the following problem appeared

Problem, No. 6.

(By W. Grimshaw.)

Black.



White.

White to play and mate in three moves.

The solution, which appeared on Nov. 6, is—

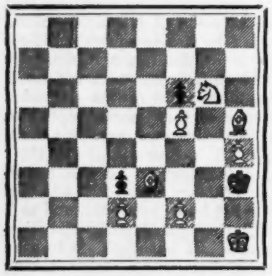
White.	Black.
1. Kt. to K.B.5.	2. B. takes Kt.
2. Q. to K.6.	3. Any move.
3. Q. or B. mates.	

The above problem, assuming this were the only solution, would be neat, but not particularly difficult. Its point, as thus solved, lies, not in the placing of the Knight on the Black Bishop's line of action, for that is an idea obvious enough; but in compelling the Black Bishop to occupy such a position that, when the White Queen goes to K.'s 6th, she will (though putting herself *en prise* by going there), threaten mate in two ways instead of one, as would be the case if she moved there at the outset.

There is, however, it so happens, a second solution, which involves a very pretty stratagem, one which hitherto we have not seen embodied in a problem. We leave our chess readers the next fortnight wherein to discover this second solution. They may suppose the other prevented by the addition of a Black Knight at Q.'s 8th, or simply that a second solution is required as a condition of the problem.

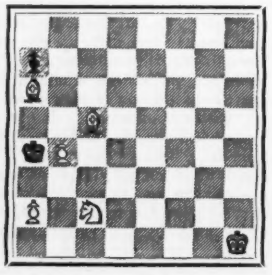
We mentioned last week a case in which a problem by the Editor (in chief) had been unmistakably anticipated, somewhat as a part of Mr. Baxter's idea in the problem of last week (No. 5, it should have been entitled) had been anticipated by the Editor. The case was on this wise. In the year 1858, the Editor sent several problems to the Chess Editor of the *Illustrated London News*, among which was the three-mover No. 7. The Chess Editor

Problem 7. By the Editor.



White to play and mate in three moves.

Problem 8. By D'Orville.



White to play and mate in three moves.

of the *Illustrated* remarked that he had seen something like this problem in the collection of D'Orville and Kling, and on the Editor writing that he had not seen that collection, the following pleasant remark appeared in the *Illustrated London News* for Oct. 9, 1858:—"R. A. P., St. John's College, Cambridge.—The following is the position by D'Orville, to which we referred [see Position 8 above]; we leave you to judge whether the resemblance is accidental." Mr. Staunton paid no attention to a disclaimer by the Editor of all knowledge of the position in question. We leave both problems as an exercise to our chess readers, leaving them to judge whether the resemblance is quite so close as to justify the remark above quoted, which followed (be it observed) a statement that the author of the later problem knew nothing of the collection by D'Orville and Kling. Strangely enough, the Editor's problem was published later (in August, 1859) in the chess column of the *Illustrated*. The Editor considers his problem so far superior to D'Orville's as to have justified him in claiming it as his own, even if he had known D'Orville's. But let others decide on that point. What the Editor would chiefly call attention to is that an experience such as his in this matter, makes him far readier than he might otherwise perhaps have been to see that even a close apparent resemblance in chess problems does not necessarily prove that there has been any borrowing.

The problem sent us by Mr. G. B. Stubbs is not quite up to publication standard. It is scarcely ever permissible for a three-mover to begin with a check, or capture (though a few instances are known of really strong problems so opening); but in the case of a two-mover like that by Mr. Stubbs, a check at the first move is quite inadmissible. There is a flaw still more serious in the existence of a dual solution, which, as Black has only one move, is a rather more serious matter than duals affecting only White's reply to moves by Black, which are not defensive. Thus there are duals in the Editor's Problem No. 4. If Black moves his Queen to Q.R.7, or 8, or to Q.B.8, or makes other purposeless moves, White can mate by moving his Rook from Q.5 to any free square; but that Black should have but one possible move, and White then be able to mate in more ways than one, is, of course, a fatal flaw in a two-mover.

Our Whist Column.

By "Five of Clubs."

When, having the original or first lead, we are obliged to lead from a short suit, as in the case considered in No. 4, p. 83, or when we have four trumps not very strong, and three of each of the other suits, we should, in general, select that suit which is least likely to injure our partner or to benefit the adversary. Of course, if your best short suit is very strong, as ace, king, queen, ace, queen, knave, ace, king, knave, or the like, you lead as from strength. Again, if you have to lead from ace, or king, or queen, and two small ones, you lead the smallest, so as not to throw away the command of the suit. You suggest, indeed, to your partner that you have led from numerical strength; but that is the misfortune of your position. It is better to do that than to give up the command in what may be a strong suit of one of the adversaries. When you have knave and two small ones, you should lead knave; because the card cannot help you against strength held by the adversary, and if your partner is strong it may help him.

But your best way of helping your partner, when you are obliged to lead from a short suit originally, is to play from a suit in which you have a strong sequence—such as queen, knave, ten; or queen, knave, and another; or knave, ten, and another. By leading the highest from such a sequence, you help your partner, if he is strong in the suit, without materially weakening yourself, if the enemy should be strong in it. Next to such hands come hands in which you have two honours and a small one. The proper leads from three-card suits, as well as from long suits, will be considered in detail later.

It can scarcely ever be advisable, no matter how your hand is constituted, to lead from ace, king, or queen, and one other. To lead from ace king, or king queen, or queen knave, alone may, in certain cases, be better than leading from a weak three-card suit. But in most cases of that kind it is better to lead from your four-card trump suit, even though it be weak.

In considering thus far the lead from a suit of three cards, we have dealt with the original lead. If you have not the original lead, then, even though only a single round has been played, you can generally form some idea of the suit you should select from among three weak non-trump suits. Thus, if your partner has led, and you have taken the trick, you should of course return his lead. Leading any other suit would imply that you had considerable strength in that suit.

If you are fourth in hand, you know at least one suit which you should not lead—viz., the one opened by your left-hand adversary. Unless, indeed, the fall of the cards in the first round showed that

he is not very strong in that suit, in which case, by leading through him, you put him at a disadvantage. Many players seem to think that the excellent general rule, lead *through* strength (that is, lead a suit in which your left-hand adversary has high cards), is a rule to be universally followed when you have no good suit of your own, and do not know which is your partner's best suit. But if your left-hand adversary leads from a suit both strong and long, and you, making first trick, lead through him in that suit, you are simply playing his game. Of the other two suits (outside trumps), you select that which you can lead with least chance of aiding the adversaries, and, as a rule, you play the best of the suit. It is an even chance that your partner is strong in it.

If you are second player, and take the first trick, you can hardly go wrong. Leading the suit your right-hand adversary had led would be doubly disadvantageous: you would be probably leading up to strength, and certainly helping to establish his suit. Of the other two suits, outside trumps, you select the best, and play the card most likely to help your partner. If you have thus led from a suit in which your left-hand adversary is strong, you at any rate lead through his strength. If your high card makes, and you then play a low one, your partner knows you have led from a short suit (or that you have made a forced lead), and infers that either you have four trumps, and no other four-card suit, or that your only four-card suit is very weak. His own hand will help to show which of the two explanations is the more probable.

With a five-card suit, however small the individual cards, it is scarcely ever wrong to lead from the long suit. Cavendish, in an amusing story in his "Card Essays," gives it as his opinion that the long suit should be led from, even with such a hand as this:—Ace, King, Queen of Spades; Eight of Clubs; Ace, King, Queen, and Three of Diamonds (trumps); Nine, Eight, Six, Four, Three of Hearts.

A YARBOROUGH HAND AT WHIST.

At the close of the letter to which we referred last week, "H. P. H." suggests a plan far calculating the odds that there will not be a Yarborough at a given deal. He says: "We must find the number of ways in which the pack must be dealt so as not to include a Yarborough. Suppose, for instance, one hand contains one of the high cards, another three of them, the third six, and the fourth ten. This arrangement may happen in

$$\frac{20 \cdot 19 \cdot 18 \cdot 17 \cdot 16 \cdot 15 \cdot 14 \cdot 13 \cdot 12 \cdot 11}{2 \cdot 3 \cdot 6 \cdot 5 \cdot 4 \cdot 3 \cdot 2} \text{ ways.*}$$

By taking all such arrangements as these, and adding the number of ways, we get the number of different arrangements of the whole pack which will not include a Yarborough; the ratio of this number to the number of different arrangements of the pack, namely, $\frac{52}{(13)^4}$ is the chance against a Yarborough happening. This would give a long piece of work, but, perhaps, some of your readers may find a short method." H. P. H.

* The reasoning here is unsound. We leave the problem as an exercise for our readers (not proposing, however, to publish all solutions which may be sent to us).

Our Mathematical Column.

MATHEMATICAL QUERIES.

[8]—Are there any exact solutions of the equations:—

$$\frac{1+\sqrt{1-x}}{1+\sqrt{1+x}} = \sqrt{1-x^2} \text{ and } \frac{1+\sqrt{1+x}}{1+\sqrt{1-x}} = \sqrt{1-x^2}.$$

[The equations are really the same, so far as any difficulty in their solution is concerned, for they differ only in the sign of x, so that whatever root we find for one, the same quantity, taken negatively, is a root of the other. But it will be found on trial that 0 is the only value of x which satisfies either equation. The solution may run thus (taking first equation):—

$$1+\sqrt{1-x} = \sqrt{1-x^2} + (1+x)\sqrt{1-x}$$
$$1 = \sqrt{1-x}(\sqrt{1+x}+x) \quad \text{(A)}$$
But $$1 = (\sqrt{1+x}+x)(\sqrt{1+x}-x) \quad \text{(B)}$$
Whence $$\sqrt{1-x} = \sqrt{1+x}-x \quad \text{(C)}$$
and $$2-2\sqrt{1-x^2} = x^2$$
i.e. $$1-x^2-2\sqrt{1-x^2}+1=0$$
$$\sqrt{1-x^2}=1$$
or $$x=0.$$

It might seem that since, after obtaining (*A*) and (*B*), which give

$$(\sqrt{1+x}+x)\ (\sqrt{1+x}-x) = \sqrt{1-x}\ (\sqrt{1+x}+x)$$

we divide by $\sqrt{1+x}+x$ to get *c*, the equation should be satisfied by the roots of

$$\sqrt{1+x}+x=0$$

which are

$$\frac{1\pm\sqrt{5}}{2}$$

but this is not the case. Neither root will satisfy the original equation, whatever signs we give the quantities $\sqrt{1-x}$ and $\sqrt{1+x}$. —Ed.]

[9]—Arithmetical Problem.—Would any reader of Knowledge favour me with a solution of the following problem:—If twelve horses eat ten acres of grass in sixteen weeks, and eighteen horses eat ten acres in eight weeks, how many horses will eat forty acres in six weeks? The grass is supposed to grow uniformly.—G. H. Mapleton.

[10]—On base *BC* are triangles *BAC*, *BDC*, having equal perimeters, *AB* being equal to *AC*. If *ACBD* intersect in *O*, show that *AO* > *DO*. Mathematicus.—[Like most problems of the kind this is best dealt with indirectly. Thus, take at point *G* in *OA* (produced if necessary) such that *OG* = *OD*, and from *OB* the greater, cut off *OF*, equal to *OC* the less, and join *FG*. Then obviously

$$FG = DC \text{ and } GC = FD$$
Hence $$FG + GC = FD + DC$$
But $$BF + FG + GC = BD + DC = BA + AC$$
$$< BF + FA + AC$$
$$\therefore\ FG + GC < FA + AC$$
or $$FG + GO < FA + AO$$

whence it follows that *G* must lie between *O* and *A*. For if *G* were at *A*, *FG* + *GO* would be the same as *FA* + *AO*; and if *G* were in *OA* produced *FG* + *GO* would be greater than *FA* + *AO*. Therefore *AO* is greater than *GO*, that is, than *DO*.—Ed.]

[11]—Perimeter of Inscribed Triangles.—Show that the perimeter of an equilateral triangle inscribed in a circle is greater than the perimeter of any other isosceles triangle inscribed in the same circle.—Mathematicus.

[Prove as follows:—Let *ABC* be the greatest triangle with a given perimeter. Then, if it be not equilateral, there must be, at least, two sides not equal to each other. Let *AB* and *BC* be unequal. Through *B* draw *KBL* parallel to base *AC*, draw *CM* perpendicular to *KL*, and produce *CM* to *N*, making *MN* = *NC*. Join *AN*, cutting *KL* in *D*, and join *DC*, *BN*. Then *BN* = *BC*, and therefore *AB* + *BC* = *AB* + *BN* > *AN* > *AD* + *DC*, so that there must be same point *P* in *DN*, such that if *PC* be joined *AP* + *PC* = *AB* + *BC*, or there is a triangle greater than *ABC*, and having the same perimeter, contrary to our supposition. Hence, no two sides of the greatest triangle with the given perimeter can be unequal, or the triangle is equiangular.—Ed.]

[12]—I wish to prove that

$$\frac{2n\ (2n-1)\ (2n-2) \cdots\ (n+1)}{1 \cdot 2 \cdot 3 \cdots\ n.}$$

The middle term in the expansion of 2^{2n} is equal to

$$1^2 + n^2 + \left(\frac{n\ (n-1)}{1 \cdot 2}\right)^2 + a \quad + n^2 + 1^2.$$

the sum of the squares of terms of the expansion of 2^n.

Proposing to do this by mathematical induction, I find, calling the first expression Σ, that when in it I write $\overline{n+1}$ for *n*, it becomes

$$\Sigma\left(1 - \frac{n^2}{(n+1)^2}\right)$$

Can I, at this point, without more ado, conclude that since

$$\Sigma = 1^2 + n^2 + a + n^2 + 1$$

(by hypothesis) when *n* becomes $n+1$ that Σ will become

$$1^2 + \overline{n+1}^2 + \left(\frac{(n+1)n}{1 \cdot 2}\right)^2 + a + \overline{n+1}^2 + 1^2$$

which would prove what I want?—F. B.

[Your demonstration is beyond us. If you write $(n+1)$ in the first expression, calling it Σ before the change, it becomes—

$$\Sigma\left(\frac{2(2n+1)}{(n+1)}\right)$$

The best way to solve your problem is this:—

$$(1+x)^n = 1 + C_1\ x + C_2\ x^2 + \&c. + C_2\ x^{n-2} + C_1\ x^{n-1} + x^n$$
$$(x+1)^n = x^n + C_1\ x^{n-1} + C_2\ x^{n-2} + \&c. + C_2\ x^2 + C_1\ x + 1$$

where C_1, C_2, C_3 are the well-known co-efficients, in the expansion of the triunial $(1+x)^n$. Multiplying—

$$(1+x)^{2n} = 1 + (C_1 + 1)\ x + (2\ C_2 + C_1^2)\ x^2 \times \&c.$$
$$+ (1 + C_1^2 + C_2^2 + C_3^2 + \ldots\ldots\ldots + C_2^2 + C_1^1 + 1)\ x^n$$
$$+ \&c. \qquad + (1 + C_1)\ x^{2n-1} + x^{2n}$$

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Hence, equating the co-efficients of x^n, we have—

$$\frac{2n\,(2n-1)\,(2n-2)\,\ldots\,(n+1)}{1\,.\,2\,.\,3\,\ldots\,n} = 1^2+n^2\div \left(\frac{n\,(n-1)}{1.2}\right)^2 + \ldots n+2+1$$

—Ed.]

[13]—Dividing an Ellipse.—I wish to know how to divide an ellipse (1) that the radius vector may cut off equal parts of the periphery, and (2) that it may divide the ellipse into equal areas.—J. A. L. R. [The latter problem is solved in my "Geometry of Cycloids," section vii. The construction for a given ellipse is sufficiently simple, and can be supplied if "J. A. L. R." particularly requires it. The former problem cannot be solved by any geometrical method of construction.—Ed.]

Answers to Correspondents.

*** All communications for the Editor requiring early attention should reach the Office on or before the Saturday preceding the current issue of* Knowledge, *the increasing circulation of which compels us to go to press early in the week.*

Hints to Correspondents.—1. *No questions asking for scientific information can be answered through the post.* 2. *Letters sent to the Editor for correspondents cannot be forwarded; nor can the names or addresses of correspondents be given in answer to private inquiries.* 3. *No queries or replies savouring of the nature of advertisements can be inserted.* 4. *Letters, queries, and replies are inserted, unless contrary to Rule* 3, *free of charge.* 5. *Correspondents should write on one side only of the paper, and put drawings on a separate leaf.* 6. *Each letter, query, or reply should have a title, and in replying to letters or queries, reference should be made to the number of letter or query, the page on which it appears, and its title.*

Newton Crosland. That would be your better course. It would please you, and everyone would understand why your letters could not appear here.—J. Belcher. Whewell's "Plurality of Worlds" is now very much out of date. It is full of suggestive matter, but even when Whewell wrote it the work was not regarded as of much scientific weight.—N. Railway noise next week; thanks.—M. E. Pendred. Having made no "certain statement against a certain body," nobody, certain or uncertain, has a right to space here in reply. You simply went out of your way to drag in the very subjects we had decided not to admit. The article you think we should not have published was practically a part of our programme. You go on to say that you would like to send us 'a letter anent the article on suicide, anent which, you ask us "this plain, straightforward, question: Is it or is it not our intention to publish correspondence anent any social question?" We answer, Not about any social questions, but about some such questions we should admit correspondence. Suicide is not an inviting subject by any means—though a review of a work recently published, on the statistics of suicide, suited our pages well enough. Whether any letter you might send on that subject appeared or not would depend on what you said in it.—J. M. Brown. Thanks for your kindly expressions about our chess. We were absolutely obliged to omit the column the week before last.—Young Stager. If phrenology has no absurdities, then "none have we offended," for we objected only to its absurdities. Thanks for the illusion, which has been submitted to Mr. Foster. We do not know who wrote the elegant lines you quote.—G. F. J. Thanks, your letter shall appear before long.—E. C. R. asks where an explanation has been offered of his query, 13, p. 60. He has searched in vain through Knowledge, he says, for any such explanation. If he will turn to query 13, p. 60, he will see, over the initials E. C. R., the explanation referred to.—Marian. "Oh, no; we never mention him" (in these columns). A. B.—Phrenology has been fairly tested, and the discrepancies between theory and observation are found to be far too numerous to be overlooked. There have been marked cases of agreement, of course, or the theory would never have had any adherents. Our readers would not care, we believe, for the article you suggest.—Ben Trovato. We understand: correspondents are to be wholly neglected, or they are to be left only a page or two of the smallest print, and we are to fill Knowledge with articles by "able individuals," preferably perhaps enlarging each number to twice the present size. We should displease correspondents, and each number would involve a heavy loss. But these are mere details. Ben Trovato "prefers such articles to the uncertain lucubrations of unknown individuals."—Jas. Green. Thanks. The illusion you illustrate had already been sent by Mr. Hodd, and before that Mr. Foster had had it in his collection. It shall appear soon, but *not*, as you suggest, at the back of a star map.—Chief Librarian. Thanks; but we are too modest to present Knowledge as published. We wait retiringly till sought for.—J. E. Gore. We will try to find room for your note on the star in Cassiopeia. Thanks.—J. A. L. R. We know beforehand that no one can tell you the number of known languages; still we insert your query.—Jas. Green. Do not you think it would be better to study the theory of evolution a little before attacking it? If you had, you would know that the theory, as now understood, involves, as an absolute necessity, the "survival of the fittest" *only*. You ask why there are not, at the present moment, examples of every gradation from one extreme to the other (from monads to monkeys, and thence to men), this being precisely the question which you would refrain from asking if you had studied even superficially the views of Darwin, Wallace, Haeckel, Spencer, and the rest. They show that the fittest survive, and you ask, Where are the others? Understand, we are not saying that they of necessity are right, and believers in the doctrine of multiplied special creations of necessity wrong. We are not urging our own or any man's opinion against yours. We are simply saying that you do not as yet know what the doctrine is which you are attacking. If you did, you would not find the points you mention militating against it.—R. C. Thanks; but that particular solution of the magic square problem has been sufficiently discussed in letters received during the last four weeks.—Mrs. Dr. Kingford. The reviewer of the "Perfect Way in Diet" should have written Mrs. rather than Miss; but so long as our present manner of speaking English remains unchanged, "Dr. Anna Kingsford" will not be regarded as a legitimate expression. A gentleman may recognise to the full a lady's professional skill, and her title to a diploma, but he can no more address her as "Doctor" or "Professor," without smiling, than he could gravely address her as "sir." Even in America, where lady professors, doctors, &c., are more numerous than here, this is found to be the case. Miss Mitchell, for instance, at Vassar College, knows more astronomy than many professors of the science in her own country and this; she is also distinctly entitled to be called Professor, and she prefers to be so called. But no man has ever yet been able so to address her in a perfectly natural manner, and the young ladies who attend her classes, though they try hard to do so, most certainly fail.—H. Fitz Hart. Ask yourself the usual question which science puts in such cases: Is there any possible relation of cause and effect in this case? And you will at once see that the hazel twig must have been held by someone who knew where water-springs were. The trick is as old as the hill- whence water-springs come.—W. A. We agree with you that there is a clear distinction between "I can but think" and "I cannot but think."—Bee. Some parts of the brain have been injured without any noticeable change, but certainly it is not "strictly true," as a general statement, that injury to the brain is not followed by any "noticeable injury."—Cuddapah. Thanks for interesting story, and for poetry; but we could not well offer a prize of £100 for a poem on knowledge.—E. Jukes. Propose to have some papers on the Arabic names of the stars shortly in Knowledge.—J. W. Chester. It is, we believe, out of print.—W. Ridd. Your solution is not correct. Will give the solution in the next number. The problem is not so simple as you seem to think. As an exercise try this. A body projected vertically upwards will not fall to the east, but to the west of the point whence it was projected; moreover, it will be travelling westwards not only when ascending, but when descending also.

This week being the Christmas holidays necessitates some slight changes of arrangement. We take the opportunity to publish matter which has been lying over for several weeks. More recent correspondents will understand the delay.

Later.—Christmas holidays, and in particular Bank Monday, cause sometimes rather inconvenient delays, increased by postal delays due to multitudinous Christmas greetings. We are prevented this week from giving our paper on the Pyramid, and a paper on the Telescope, by a Fellow of the Royal Astronomical Society, because the illustrations for both these papers were not in hand in good time. However, so far as the latter paper is concerned, it is fitting that it should appear in the first number of the New Year, in which also will be the first of our monthly Star Maps, in which some features have been introduced which, we believe, our readers will regard as decided improvements.

The Protective Effect of Vaccination.—Dr. Henry Tomkins, medical superintendent of the fever hospital belonging to the Manchester Royal Infirmary at Monsall, in a paper which he read recently at Owens College, said:—"The most striking of all evidence is, perhaps, that derived from the small-pox hospitals themselves. Here the protective influence of vaccination is seen and proved in a manner beyond all cavil. At Highgate, during an experience of forty years, no nurse or servant, having been re-vaccinated, has ever contracted the disease, and evidence of the same character I can myself bring forward, for during the whole time that I have had charge of the fever hospital, more than a thousand cases of small-pox have passed under my care, yet no servant, nurse, porter or other person engaged there has, after re-vaccination, ever taken it, though exposed daily to infection in its most concentrated form. One woman, a laundress, who escaped vaccination, took the disease and died; one nurse, who some years before had suffered from small-pox, and was then considered protected, had a very mild attack; and this summer a workman, who did not live on the premises, but came in to work as a painter, was not vaccinated, and had rather a severe attack; and still more recently a servant, who by an oversight was allowed to go about her work three days before being vaccinated, had, before the latter had run its course, a slight abortive attack. Again, among all the students who during the past two years have attended the hospital for clinical instruction, not one has suffered, all having been re-vaccinated before being permitted to enter the small-pox wards. And in their case the false argument which opponents of vaccination have brought forward to explain the immunity enjoyed by nurses and others in attendance on the sick,—viz., that constant intercourse and exposure to infection renders them proof against it by the system becoming inured to the poison, cannot be applied, as these gentlemen attend the hospital only a few hours once a week. I defy the most enthusiastic or conscientious of anti-vaccinators to produce evidence like this on his side of the question, or to bring forward even half-a-dozen persons, choose them whence he may, who have not been protected against small-pox, and expose them as the students are exposed, without more or less of the number taking the disease. Facts such as these should convert the most ardent anti-vaccinator from his folly, and convince him that a weapon of defence so powerful as vaccination should not be left to the pleasure of the individual, but that the State has the right and duty to look after its most thorough performance.—*Times*.

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